Evaluation and Analysis of Environmental Performance and Benefit of Environmentally-Advantaged Aircraft Deicing Fluids

Development of the Decision Support Methodology and Case Studies

Prepared for: **SAIC**

April 2008

LimnoTech
Water | Environment | Scientists | Engineers
CH2MHILL
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14. ABSTRACT

At the direction of ESTCP, the Project Team of LimnoTech and CH2M HILL developed and demonstrated a tool for airfield environmental managers to use in evaluating the potential environmental benefits of an aircraft deicing fluid (ADF) with different environmental properties than currently used products. The specific interest is in determining if a newly developed ADF represents significant advantages in terms of environmental impact, regulatory compliance, and compliance costs.
The work consisted of two efforts: 1. The development of a Decision Support Tool for environmental managers at U.S. Air Force and Air National Guard facilities to allow for the semi-quantitative evaluation of benefits that could be realized by switching from a propylene glycol-based aircraft deicing fluid to an alternative fluid, and 2. Application of the Decision Support Tool in a series of case studies to provide real-world examples.

15. SUBJECT TERMS

aircraft deicing fluids, decision support tool, BOD5, environmental benefit, and propylene glycol

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1. INTRODUCTION

At the direction of ESTCP, the Project Team of LimnoTech and CH2M HILL has developed and demonstrated a tool for airfield environmental managers to use in evaluating the potential environmental benefits of an aircraft deicing fluid (ADF) with different environmental properties than currently used products. The specific interest is in determining if a newly developed ADF represents significant advantages in terms of environmental impact, regulatory compliance, and compliance costs.

The work consisted of two efforts:

1. The development of a Decision Support Tool for environmental managers at U.S. Air Force and Air National Guard facilities to allow for the semi-quantitative evaluation of benefits that could be realized by switching from a propylene glycol-based aircraft deicing fluid to an alternative fluid, and
2. Application of the Decision Support Tool in a series of case studies to provide real-world examples.

Sections 2 and 3 of this document contain descriptions of the Decision Support Tool development and the Case Studies, respectively.

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2. DECISION SUPPORT TOOL DEVELOPMENT

The development of the Decision Support Tool was accomplished through the collaborative identification of factors important in supporting the analysis of changing the type of ADF used at a facility. The tool was implemented as a Microsoft Excel® workbook to provide a familiar interface and ensure wide access to the tool's analytical capabilities. A series of progressively refined versions of the tool were developed and tested by the project team, resulting in the final version that is shown in Figure 1.

The "Evaluation Worksheet for Alternative Aircraft Deicers" gives environmental managers a tool with which to perform a semi-quantitative screening-level assessment of likely environmental and regulatory compliance implications resulting from a change in ADF used at their facility. The user specifies current deicing fluid usage, collection, discharge, and disposal information. The spreadsheet performs a series of calculations and provides feedback to the user describing the potential changes in compliance achievement and operational costs that may result from a change in ADF usage.

Several areas of possible environmental and operational benefits are considered in the support tool:

- **Aquatic toxicity**. The tool compares reported aquatic toxicities for the current and proposed ADFs and advises on likely reductions of potential toxic effects from fugitive emissions and discharges.

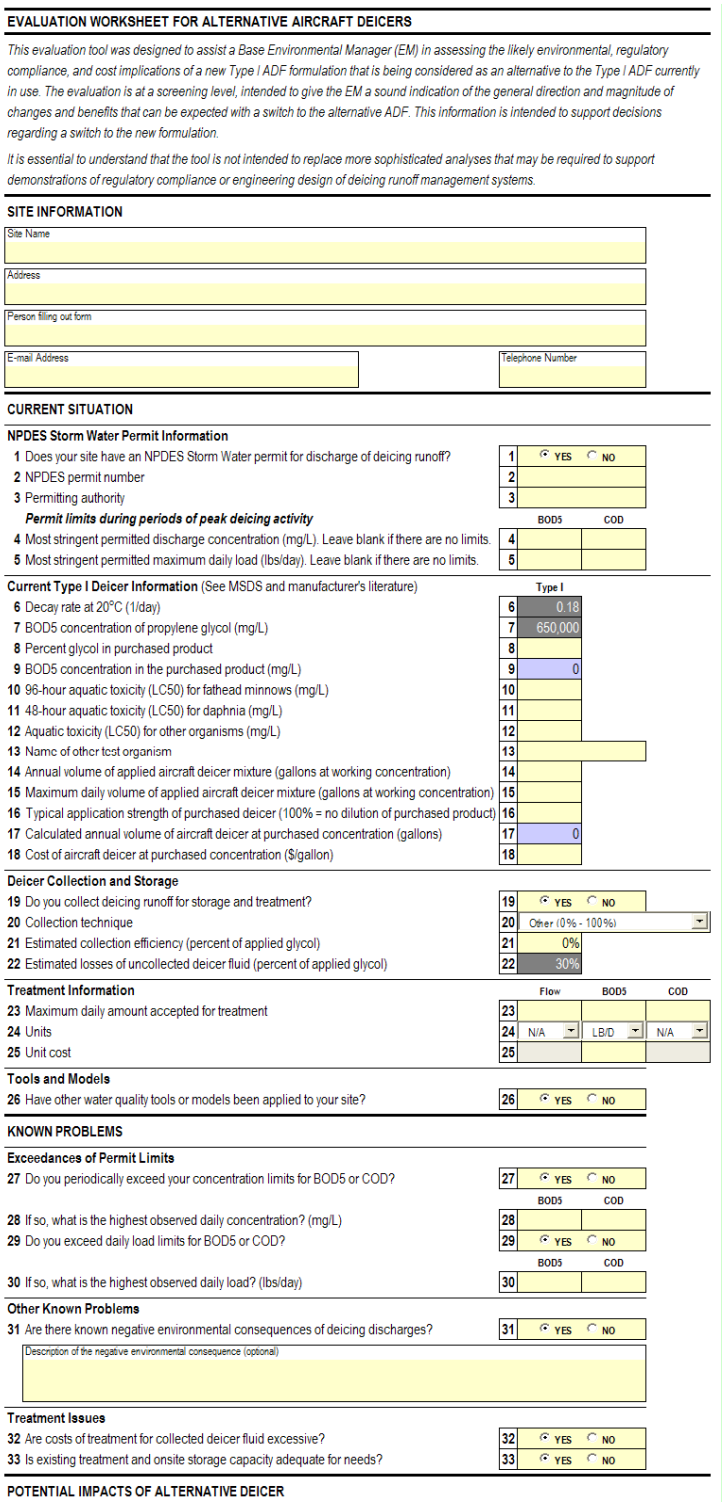
- **Permit compliance**. The tool uses permit and monitoring information together with ADF characteristics to evaluate possible improvements in compliance with mass or concentration limits in discharge permits.

- **Oxygen depletion in receiving waters.** In situations where deicing fluid reaches a stream or river, the tool can use ADF characteristics together with information about stream flow, temperature, and other parameters to estimate possible reductions in impacts of dissolved oxygen in the stream.

- **Treatment costs and efficiency**. The tool uses ADF characteristics together with treatment capacity and cost information provided by the user to estimate potential cost savings and increase in storage availability from use of an alternative ADF.

- **Product costs.** The cost implications of switching to the alternative fluid are estimated in terms of change in average annual expenditures.

Instructions are provided to guide the user through the data input process. The instructions include a description of each input to the tool and guidance on identifying the appropriate data or information required for each field. A copy of the instructions is included as Attachment 1.



EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS

This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory compliance, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF currently in use. The evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions regarding a switch to the new formulation.

It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

SITE INFORMATION

Site Name

Address

Person filling out form

E-mail Address | Telephone Number

CURRENT SITUATION

NPDES Storm Water Permit Information

1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1	YES / NO
2 NPDES permit number	2	
3 Permitting authority	3	
Permit limits during periods of peak deicing activity		BOD5 / COD
4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4	
5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5	

Current Type I Deicer Information (See MSDS and manufacturer's literature)		Type I
6 Decay rate at 20°C (1/day)	6	0.18
7 BOD5 concentration of propylene glycol (mg/L)	7	650,000
8 Percent glycol in purchased product	8	
9 BOD5 concentration in the purchased product (mg/L)	9	0
10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10	
11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11	
12 Aquatic toxicity (LC50) for other organisms (mg/L)	12	
13 Name of other test organism	13	
14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14	
15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15	
16 Typical application strength of purchased deicer (100% = no dilution of purchased product)	16	
17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17	0
18 Cost of aircraft deicer at purchased concentration ($/gallon)	18	

Deicer Collection and Storage

19 Do you collect deicing runoff for storage and treatment?	19	YES / NO
20 Collection technique	20	Other (0% - 100%)
21 Estimated collection efficiency (percent of applied glycol)	21	0%
22 Estimated losses of uncollected deicer fluid (percent of applied glycol)	22	30%

Treatment Information		Flow	BOD5	COD
23 Maximum daily amount accepted for treatment	23			
24 Units	24	N/A	LB/D	N/A
25 Unit cost	25			

Tools and Models

26 Have other water quality tools or models been applied to your site?	26	YES / NO

KNOWN PROBLEMS

Exceedances of Permit Limits

27 Do you periodically exceed your concentration limits for BOD5 or COD?	27	YES / NO
		BOD5 / COD
28 If so, what is the highest observed daily concentration? (mg/L)	28	
29 Do you exceed daily load limits for BOD5 or COD?	29	YES / NO
		BOD5 / COD
30 If so, what is the highest observed daily load? (lbs/day)	30	

Other Known Problems

31 Are there known negative environmental consequences of deicing discharges?	31	YES / NO

Description of the negative environmental consequence (optional)

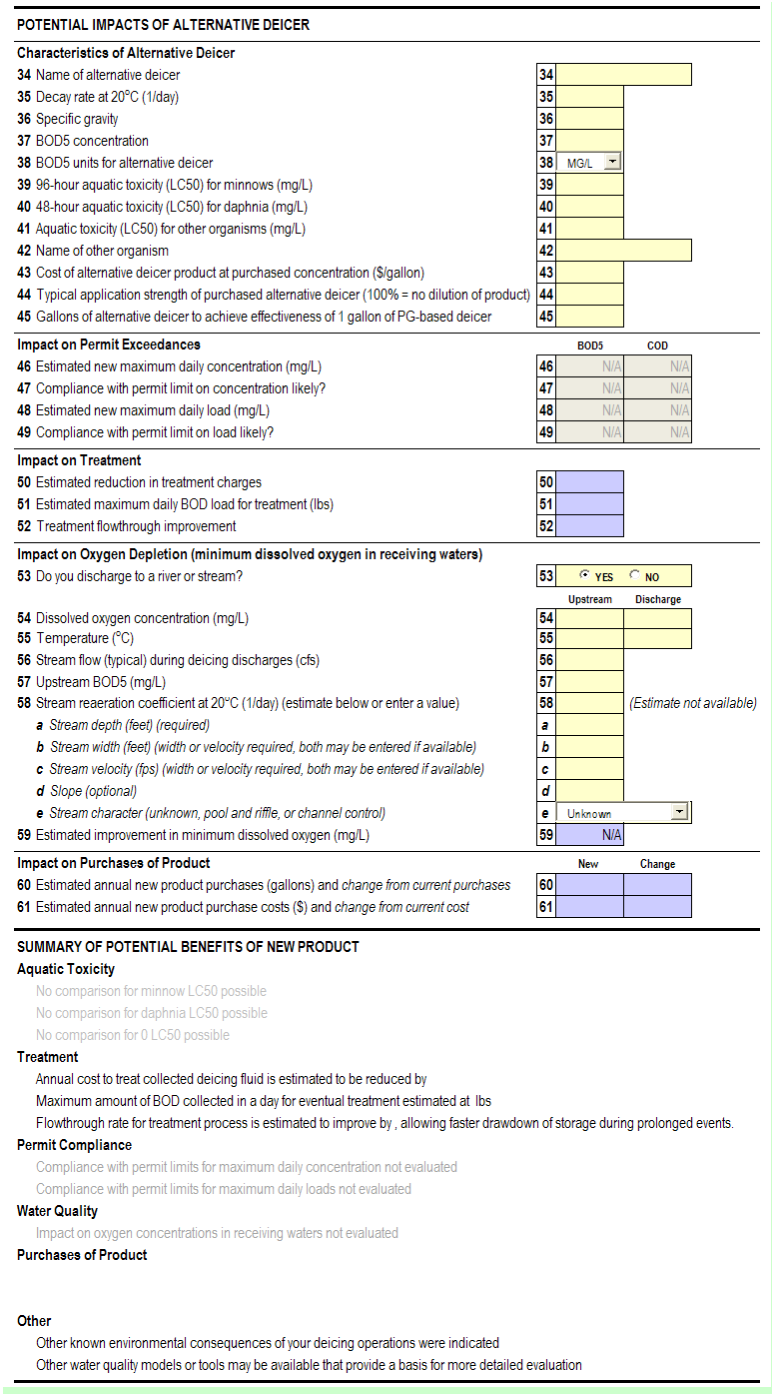
Treatment Issues

32 Are costs of treatment for collected deicer fluid excessive?	32	YES / NO
33 Is existing treatment and onsite storage capacity adequate for needs?	33	YES / NO

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Figure 1. Evaluation Worksheet for Alternative Deicer Fluids

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet.xls, to better view the decision support tool inputs on a computer screen.



POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Characteristics of Alternative Deicer

34	Name of alternative deicer	
35	Decay rate at 20°C (1/day)	
36	Specific gravity	
37	BOD5 concentration	
38	BOD5 units for alternative deicer	MG/L
39	96-hour aquatic toxicity (LC50) for minnows (mg/L)	
40	48-hour aquatic toxicity (LC50) for daphnia (mg/L)	
41	Aquatic toxicity (LC50) for other organisms (mg/L)	
42	Name of other organism	
43	Cost of alternative deicer product at purchased concentration ($/gallon)	
44	Typical application strength of purchased alternative deicer (100% = no dilution of product)	
45	Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	

Impact on Permit Exceedances		BOD5	COD
46	Estimated new maximum daily concentration (mg/L)	N/A	N/A
47	Compliance with permit limit on concentration likely?	N/A	N/A
48	Estimated new maximum daily load (mg/L)	N/A	N/A
49	Compliance with permit limit on load likely?	N/A	N/A

Impact on Treatment

50	Estimated reduction in treatment charges	
51	Estimated maximum daily BOD load for treatment (lbs)	
52	Treatment flowthrough improvement	

Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)

53	Do you discharge to a river or stream?		YES / NO	
		Upstream	Discharge	
54	Dissolved oxygen concentration (mg/L)			
55	Temperature (°C)			
56	Stream flow (typical) during deicing discharges (cfs)			
57	Upstream BOD5 (mg/L)			
58	Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)			*(Estimate not available)*
a	*Stream depth (feet) (required)*			
b	*Stream width (feet) (width or velocity required, both may be entered if available)*			
c	*Stream velocity (fps) (width or velocity required, both may be entered if available)*			
d	*Slope (optional)*			
e	*Stream character (unknown, pool and riffle, or channel control)*		Unknown	
59	Estimated improvement in minimum dissolved oxygen (mg/L)		N/A	

Impact on Purchases of Product		New	Change
60	Estimated annual new product purchases (gallons) and *change from current purchases*		
61	Estimated annual new product purchase costs ($) and *change from current cost*		

SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT

Aquatic Toxicity

No comparison for minnow LC50 possible
No comparison for daphnia LC50 possible
No comparison for 0 LC50 possible

Treatment

Annual cost to treat collected deicing fluid is estimated to be reduced by
Maximum amount of BOD collected in a day for eventual treatment estimated at lbs
Flowthrough rate for treatment process is estimated to improve by , allowing faster drawdown of storage during prolonged events.

Permit Compliance

Compliance with permit limits for maximum daily concentration not evaluated
Compliance with permit limits for maximum daily loads not evaluated

Water Quality

Impact on oxygen concentrations in receiving waters not evaluated

Purchases of Product

Other

Other known environmental consequences of your deicing operations were indicated
Other water quality models or tools may be available that provide a basis for more detailed evaluation

Figure 1. Evaluation Worksheet for Alternative Deicer Fluids (continued)

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet.xls, to better view the decision support tool inputs on a computer screen.

The results of the analyses performed by the tool are presented in a summary list at the end of the worksheet The worksheet is designed to be printed out for examination and archiving. The Decision Support Tool and instructions are included as an electronic attachment to this document.

3. CASE STUDIES

Three facilities were used to test the Decision Support Tool: 1) the Pennsylvania Air National Guard facility (PIT) located at the Pittsburgh International Airport, 2) the Maine Air National Guard facility (BNG) located at the Bangor International Airport, and 3) the Portland International Airport (PDX) in Portland, Oregon. The sites were selected to allow evaluation of the Decision Support Tool across a range of facility sizes, glycol usage rates, and collection strategies.

3.1 CASE STUDY SUMMARIES

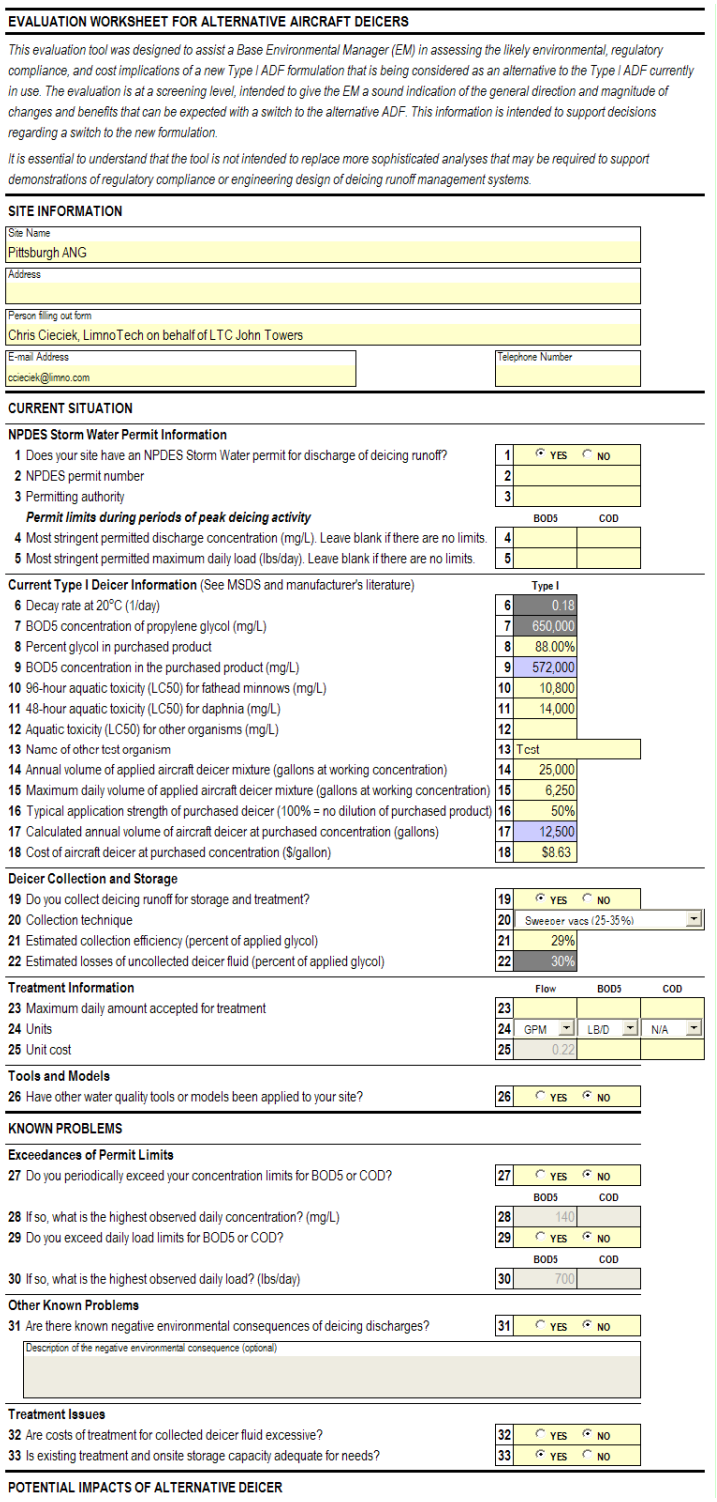
The three case studies are described in the following subsections.

3.1.1 Pittsburgh ANG (PIT)

The Pittsburgh Air National Guard facility at the Pittsburgh International Airport is home to the 171st Air Refueling Wing. The 171st has a fleet of KC-135 tankers that conduct refueling missions, as well as cargo and passenger transport mission services. LTC John Tower, Environmental Coordinator provided daily ADF usage data for the seasons 2002-03 through 2006-07 for the Pittsburgh Air National Guard facility. Average annual reported glycol usage was 12,800 gallons and ranged from a minimum of 9,600 gallons to a maximum of 17,600 gallons during the 2006-07 and 2003-04 seasons, respectively. Recovery data for the 2005-06 and 2006-07 seasons was also provided. The average calculated seasonal collection efficiency estimate of 29% was developed based upon conversations with LTC Tower regarding glycol recovery vehicle (GRV) performance and using the average concentration of glycol observed in truck loads for which glycol concentrations were measured during each season.

The application of the Decision Support Tool to the Pittsburgh ANG facility is shown in Figure 2. The following highlights of the analysis summarize the case study findings:

- Because information regarding PIT's NPDES permit was not provided, an evaluation of potential permit compliance implications was not conducted.
- The following benefits are indicated for the theoretical replacement of conventional PG-based ADF product with one having characteristics similar to LBOD ADF:
    - Estimated reduction in annual treatment costs for collected runoff of approximately $22,000 and the flow through rate of the collection system is estimated to increase by approximately 180%.
    - Reduced aquatic toxicity in deicing discharges.
    - Savings of approximately $20,000 annually due to the decreased unit cost of the alternative ADF product.



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It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

SITE INFORMATION

Site Name: Pittsburgh ANG

Address:

Person filling out form: Chris Cieciek, LimnoTech on behalf of LTC John Towers

E-mail Address: ccieciek@limno.com

Telephone Number:

CURRENT SITUATION

NPDES Storm Water Permit Information

1 Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1	YES / NO
2 NPDES permit number	2	
3 Permitting authority	3	
Permit limits during periods of peak deicing activity		BOD5 / COD
4 Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4	
5 Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5	

Current Type I Deicer Information (See MSDS and manufacturer's literature)		Type I
6 Decay rate at 20°C (1/day)	6	0.18
7 BOD5 concentration of propylene glycol (mg/L)	7	650,000
8 Percent glycol in purchased product	8	88.00%
9 BOD5 concentration in the purchased product (mg/L)	9	572,000
10 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10	10,800
11 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11	14,000
12 Aquatic toxicity (LC50) for other organisms (mg/L)	12	
13 Name of other test organism	13	Test
14 Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14	25,000
15 Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15	6,250
16 Typical application strength of purchased deicer (100% = no dilution of purchased product)	16	50%
17 Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17	12,500
18 Cost of aircraft deicer at purchased concentration ($/gallon)	18	$8.63

Deicer Collection and Storage

19 Do you collect deicing runoff for storage and treatment?	19	YES / NO
20 Collection technique	20	Sweeper vacs (25-35%)
21 Estimated collection efficiency (percent of applied glycol)	21	29%
22 Estimated losses of uncollected deicer fluid (percent of applied glycol)	22	30%

Treatment Information		Flow	BOD5	COD
23 Maximum daily amount accepted for treatment	23			
24 Units	24	GPM	LB/D	N/A
25 Unit cost	25	0.22		

Tools and Models

26 Have other water quality tools or models been applied to your site?	26	YES / NO

KNOWN PROBLEMS

Exceedances of Permit Limits

27 Do you periodically exceed your concentration limits for BOD5 or COD?	27	YES / NO
		BOD5 / COD
28 If so, what is the highest observed daily concentration? (mg/L)	28	140
29 Do you exceed daily load limits for BOD5 or COD?	29	YES / NO
		BOD5 / COD
30 If so, what is the highest observed daily load? (lbs/day)	30	700

Other Known Problems

31 Are there known negative environmental consequences of deicing discharges?	31	YES / NO

Description of the negative environmental consequence (optional)

Treatment Issues

32 Are costs of treatment for collected deicer fluid excessive?	32	YES / NO
33 Is existing treatment and onsite storage capacity adequate for needs?	33	YES / NO

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Figure 2. Pittsburgh ANG Evaluation

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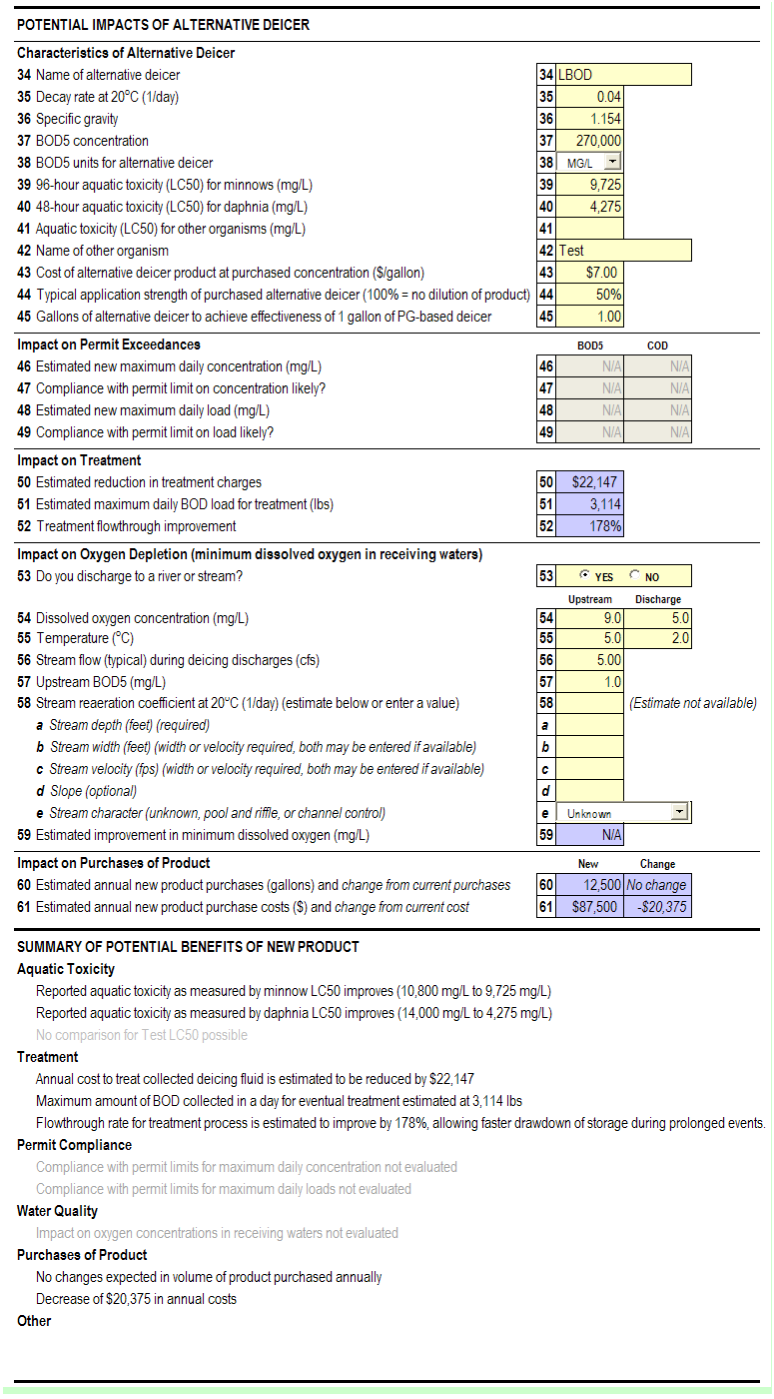

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Characteristics of Alternative Deicer				
34 Name of alternative deicer	34	LBOD		
35 Decay rate at 20°C (1/day)	35	0.04		
36 Specific gravity	36	1.154		
37 BOD5 concentration	37	270,000		
38 BOD5 units for alternative deicer	38	MG/L		
39 96-hour aquatic toxicity (LC50) for minnows (mg/L)	39	9,725		
40 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	40	4,275		
41 Aquatic toxicity (LC50) for other organisms (mg/L)	41			
42 Name of other organism	42	Test		
43 Cost of alternative deicer product at purchased concentration ($/gallon)	43	$7.00		
44 Typical application strength of purchased alternative deicer (100% = no dilution of product)	44	50%		
45 Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	45	1.00		
Impact on Permit Exceedances			BOD5	COD
46 Estimated new maximum daily concentration (mg/L)	46		N/A	N/A
47 Compliance with permit limit on concentration likely?	47		N/A	N/A
48 Estimated new maximum daily load (mg/L)	48		N/A	N/A
49 Compliance with permit limit on load likely?	49		N/A	N/A
Impact on Treatment				
50 Estimated reduction in treatment charges	50	$22,147		
51 Estimated maximum daily BOD load for treatment (lbs)	51	3,114		
52 Treatment flowthrough improvement	52	178%		
Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)				
53 Do you discharge to a river or stream?	53	YES / NO		
			Upstream	Discharge
54 Dissolved oxygen concentration (mg/L)	54		9.0	5.0
55 Temperature (°C)	55		5.0	2.0
56 Stream flow (typical) during deicing discharges (cfs)	56		5.00	
57 Upstream BOD5 (mg/L)	57		1.0	
58 Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)	58			*(Estimate not available)*
a Stream depth (feet) (required)	a			
b Stream width (feet) (width or velocity required, both may be entered if available)	b			
c Stream velocity (fps) (width or velocity required, both may be entered if available)	c			
d Slope (optional)	d			
e Stream character (unknown, pool and riffle, or channel control)	e	Unknown		
59 Estimated improvement in minimum dissolved oxygen (mg/L)	59		N/A	
Impact on Purchases of Product			New	Change
60 Estimated annual new product purchases (gallons) and *change from current purchases*	60		12,500	*No change*
61 Estimated annual new product purchase costs ($) and *change from current cost*	61		$87,500	*-$20,375*

SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT

Aquatic Toxicity
- Reported aquatic toxicity as measured by minnow LC50 improves (10,800 mg/L to 9,725 mg/L)
- Reported aquatic toxicity as measured by daphnia LC50 improves (14,000 mg/L to 4,275 mg/L)
- No comparison for Test LC50 possible

Treatment
- Annual cost to treat collected deicing fluid is estimated to be reduced by $22,147
- Maximum amount of BOD collected in a day for eventual treatment estimated at 3,114 lbs
- Flowthrough rate for treatment process is estimated to improve by 178%, allowing faster drawdown of storage during prolonged events.

Permit Compliance
- Compliance with permit limits for maximum daily concentration not evaluated
- Compliance with permit limits for maximum daily loads not evaluated

Water Quality
- Impact on oxygen concentrations in receiving waters not evaluated

Purchases of Product
- No changes expected in volume of product purchased annually
- Decrease of $20,375 in annual costs

Other

Figure 2. Pittsburgh ANG Evaluation (continued)

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3.1.2 Maine ANG (MEANG)

The Maine Air National Guard facility at the Bangor International Airport (BGR) is home to the 101st Air Refueling Wing. 101 ARW flies KC-135 aircraft in support of refueling and transport missions. The unit has a high OPSTEMPO relative to other ANG units consistently delivering over 12 million gallons of fuel per year and receiving over 650 transients per year. LTC D. Eric Johns, Environmental Manager at the MEANG facility provided daily ADF usage and sanitary sewer discharge data for collected ADF runoff for the seasons 2003-04 through 2006-07. Average annual reported glycol usage was 25,700 gallons and ranged from a minimum of 17,200 gallons to a maximum of 36,200 gallons during the 2003-04 and 2006-07 seasons, respectively. Sanitary sewer discharge data was compared to usage data to calculate collection efficiency estimates for each season. The average collection efficiency was 50%, and ranged from a minimum of 45% to a maximum of 56% during the 2003-04 and 2006-07 seasons, respectively.

The application of the Decision Support Tool to the MEANG facility is shown in Figure 3. The following highlights of the analysis summarize the case study findings:

- Because BNG's NPDES permit does not contain numeric limits for its storm water discharge, an evaluation of potential permit compliance benefits was not conducted.

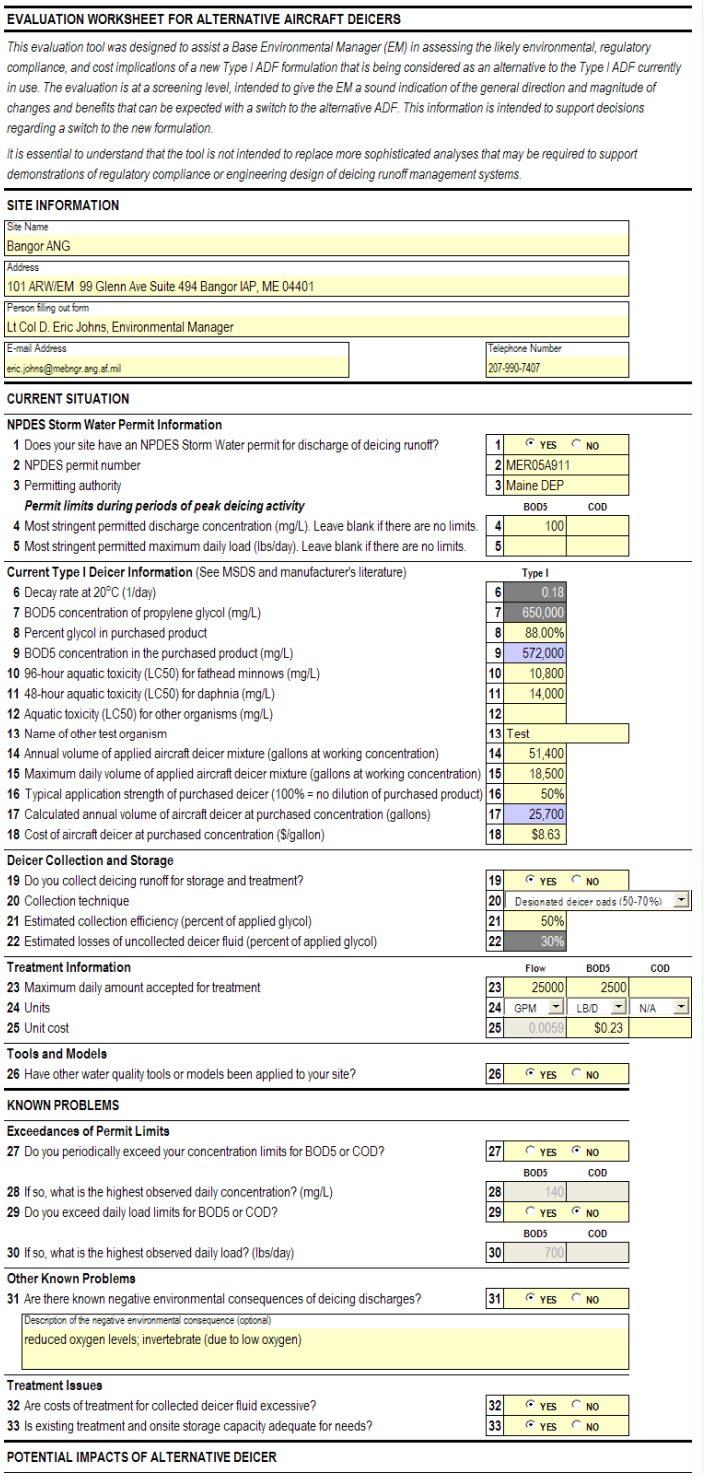
- The following benefits are indicated for the theoretical replacement of conventional PG-based ADF product with one having characteristics similar to LBOD ADF:

    - Reduction in annual treatment costs for collected runoff of approximately $78,000 and the flow through rate of the collection system is estimated to increase by approximately 180%.

    - Reduced aquatic toxicity in deicing discharges.

    - Savings of approximately $42,000 annually due to the decreased unit cost of the alternative ADF product.

- The Decision Support Tool notes that other known environmental consequences were indicated (e.g. reduced oxygen levels and invertebrates) and suggests that other more sophisticated water quality models or tools may be appropriate to provide a more detailed analysis.



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It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

SITE INFORMATION

Site Name	Bangor ANG
Address	101 ARW/EM 99 Glenn Ave Suite 494 Bangor IAP, ME 04401
Person filling out form	Lt Col D. Eric Johns, Environmental Manager
E-mail Address	eric.johns@mebngr.ang.af.mil
Telephone Number	207-990-7407

CURRENT SITUATION

NPDES Storm Water Permit Information

1	Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1	YES / NO
2	NPDES permit number	2	MER05A911
3	Permitting authority	3	Maine DEP
	Permit limits during periods of peak deicing activity		BOD5 / COD
4	Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4	100
5	Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5	

Current Type I Deicer Information (See MSDS and manufacturer's literature)

			Type I
6	Decay rate at 20°C (1/day)	6	0.18
7	BOD5 concentration of propylene glycol (mg/L)	7	650,000
8	Percent glycol in purchased product	8	88.00%
9	BOD5 concentration in the purchased product (mg/L)	9	572,000
10	96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10	10,800
11	48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11	14,000
12	Aquatic toxicity (LC50) for other organisms (mg/L)	12	
13	Name of other test organism	13	Test
14	Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14	51,400
15	Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15	18,500
16	Typical application strength of purchased deicer (100% = no dilution of purchased product)	16	50%
17	Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17	25,700
18	Cost of aircraft deicer at purchased concentration ($/gallon)	18	$8.63

Deicer Collection and Storage

19	Do you collect deicing runoff for storage and treatment?	19	YES / NO
20	Collection technique	20	Designated deicer pads (50-70%)
21	Estimated collection efficiency (percent of applied glycol)	21	50%
22	Estimated losses of uncollected deicer fluid (percent of applied glycol)	22	30%

Treatment Information

			Flow	BOD5	COD
23	Maximum daily amount accepted for treatment	23	25000	2500	
24	Units	24	GPM	LB/D	N/A
25	Unit cost	25	0.0059	$0.23	

Tools and Models

26	Have other water quality tools or models been applied to your site?	26	YES / NO

KNOWN PROBLEMS

Exceedances of Permit Limits

27	Do you periodically exceed your concentration limits for BOD5 or COD?	27	YES / NO
			BOD5 / COD
28	If so, what is the highest observed daily concentration? (mg/L)	28	140
29	Do you exceed daily load limits for BOD5 or COD?	29	YES / NO
			BOD5 / COD
30	If so, what is the highest observed daily load? (lbs/day)	30	700

Other Known Problems

31	Are there known negative environmental consequences of deicing discharges?	31	YES / NO

Description of the negative environmental consequence (optional)
reduced oxygen levels; invertebrate (due to low oxygen)

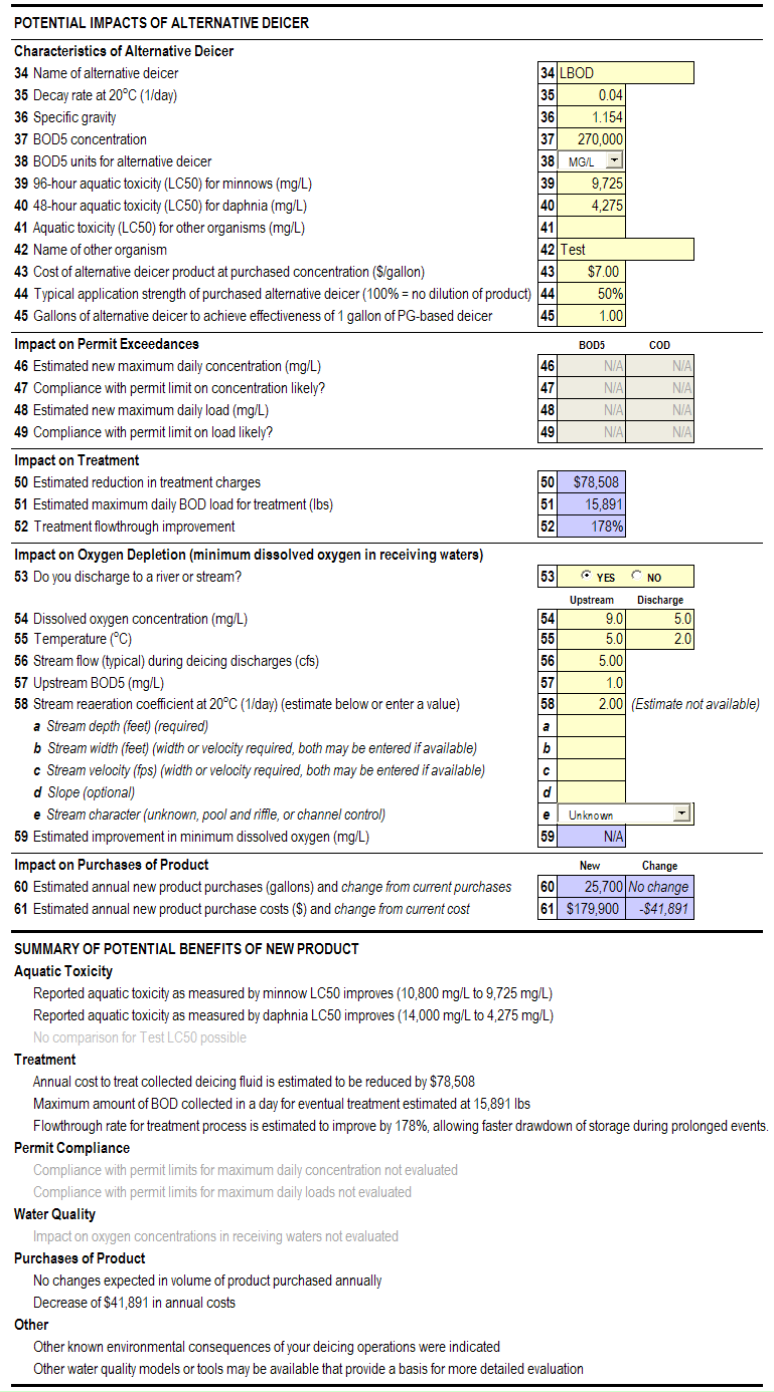
Treatment Issues

32	Are costs of treatment for collected deicer fluid excessive?	32	YES / NO
33	Is existing treatment and onsite storage capacity adequate for needs?	33	YES / NO

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Figure 3. Bangor ANG Evaluation

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet BGR.xls, to better view the decision support tool inputs on a computer screen.



POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Characteristics of Alternative Deicer				
34 Name of alternative deicer	34	LBOD		
35 Decay rate at 20°C (1/day)	35	0.04		
36 Specific gravity	36	1.154		
37 BOD5 concentration	37	270,000		
38 BOD5 units for alternative deicer	38	MG/L		
39 96-hour aquatic toxicity (LC50) for minnows (mg/L)	39	9,725		
40 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	40	4,275		
41 Aquatic toxicity (LC50) for other organisms (mg/L)	41			
42 Name of other organism	42	Test		
43 Cost of alternative deicer product at purchased concentration ($/gallon)	43	$7.00		
44 Typical application strength of purchased alternative deicer (100% = no dilution of product)	44	50%		
45 Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	45	1.00		
Impact on Permit Exceedances			BOD5	COD
46 Estimated new maximum daily concentration (mg/L)	46		N/A	N/A
47 Compliance with permit limit on concentration likely?	47		N/A	N/A
48 Estimated new maximum daily load (mg/L)	48		N/A	N/A
49 Compliance with permit limit on load likely?	49		N/A	N/A
Impact on Treatment				
50 Estimated reduction in treatment charges	50	$78,508		
51 Estimated maximum daily BOD load for treatment (lbs)	51	15,891		
52 Treatment flowthrough improvement	52	178%		
Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)				
53 Do you discharge to a river or stream?	53	YES / NO		
			Upstream	Discharge
54 Dissolved oxygen concentration (mg/L)	54		9.0	5.0
55 Temperature (°C)	55		5.0	2.0
56 Stream flow (typical) during deicing discharges (cfs)	56		5.00	
57 Upstream BOD5 (mg/L)	57		1.0	
58 Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)	58		2.00	*(Estimate not available)*
a Stream depth (feet) (required)	a			
b Stream width (feet) (width or velocity required, both may be entered if available)	b			
c Stream velocity (fps) (width or velocity required, both may be entered if available)	c			
d Slope (optional)	d			
e Stream character (unknown, pool and riffle, or channel control)	e	Unknown		
59 Estimated improvement in minimum dissolved oxygen (mg/L)	59		N/A	
Impact on Purchases of Product			New	Change
60 Estimated annual new product purchases (gallons) and *change from current purchases*	60		25,700	*No change*
61 Estimated annual new product purchase costs ($) and *change from current cost*	61		$179,900	*-$41,691*

SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT

Aquatic Toxicity
- Reported aquatic toxicity as measured by minnow LC50 improves (10,800 mg/L to 9,725 mg/L)
- Reported aquatic toxicity as measured by daphnia LC50 improves (14,000 mg/L to 4,275 mg/L)
- No comparison for Test LC50 possible

Treatment
- Annual cost to treat collected deicing fluid is estimated to be reduced by $78,508
- Maximum amount of BOD collected in a day for eventual treatment estimated at 15,891 lbs
- Flowthrough rate for treatment process is estimated to improve by 178%, allowing faster drawdown of storage during prolonged events.

Permit Compliance
- Compliance with permit limits for maximum daily concentration not evaluated
- Compliance with permit limits for maximum daily loads not evaluated

Water Quality
- Impact on oxygen concentrations in receiving waters not evaluated

Purchases of Product
- No changes expected in volume of product purchased annually
- Decrease of $41,891 in annual costs

Other
- Other known environmental consequences of your deicing operations were indicated
- Other water quality models or tools may be available that provide a basis for more detailed evaluation

Figure 3. Bangor ANG Evaluation (continued)

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet BGR.xls, to better view the decision support tool inputs on a computer screen.

3.1.3 Portland International Airport (PDX)

Portland International Airport is a medium-sized commercial hub airport serving passenger, cargo, and military flight operations. PDX differs significantly from PIT and BGR in that more deicing activity occurs there than at the Air National Guard bases. The potential environmental impacts of deicing are a significant concern to the airport because all stormwater discharges go to the Columbia Slough, a small, impaired water body that is the subject of a Total Maximum Daily Load for, among other things, dissolved oxygen.

Data from previous investigations at Portland International Airport (PDX) were available to support evaluation of the Decision Support Tool. LimnoTech and CH2M-HILL previously developed highly detailed airfield storm water and receiving models for PDX, along with extensive deicer usage and discharge datasets. Daily ADF usage and storm water and sanitary sewer discharge information and data from the 1995-96 through 2003-04 seasons were used to develop estimates of average annual and maximum daily ADF usage rates, collection efficiency, and discharge/disposal costs for the Decision Support Tool.

The Decision Support Tool configured for PDX is shown in Figure 4. The following highlights of the analysis summarize the case study findings:

- The evaluation of implications for permit compliance issues indicates that reductions in storm water discharge maximum BOD_5 concentrations from approximately 140 mg/L to 50 mg/L and the change in the maximum daily BOD_5 load to approximately 200 pounds are likely to ensure future compliance.

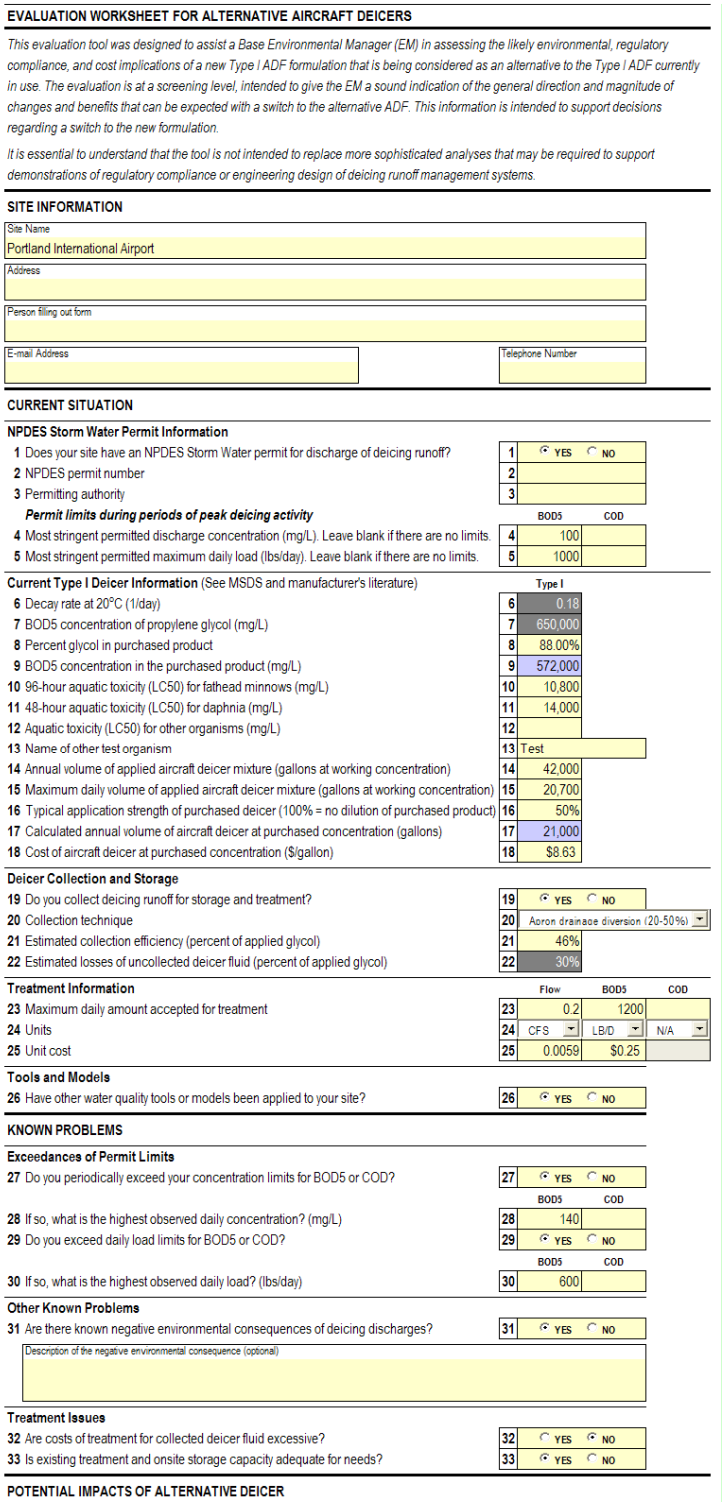
- The following benefits are indicated for the theoretical replacement of conventional PG-based ADF product with one having characteristics similar to LBOD ADF:

    - A reduction in treatment costs for collected runoff of approximately $59,000 and an increase in the flow through rate of the collection system by approximately 180%.

    - Reduced aquatic toxicity in deicing discharges.

    - Savings of approximately $34,000 in annual costs due to the decreased unit cost of the alternative ADF product.

- The Decision Support Tool notes that other known environmental consequences were indicated and suggests that other more sophisticated water quality models or tools may be appropriate to provide a more detailed analysis.



EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS

This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory compliance, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF currently in use. The evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions regarding a switch to the new formulation.

It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

SITE INFORMATION

Site Name	Portland International Airport
Address	
Person filling out form	
E-mail Address	
Telephone Number	

CURRENT SITUATION

NPDES Storm Water Permit Information

1	Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1	YES / NO
2	NPDES permit number	2	
3	Permitting authority	3	
	Permit limits during periods of peak deicing activity		BOD5 / COD
4	Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4	100
5	Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5	1000

	Current Type I Deicer Information (See MSDS and manufacturer's literature)		Type I
6	Decay rate at 20°C (1/day)	6	0.18
7	BOD5 concentration of propylene glycol (mg/L)	7	650,000
8	Percent glycol in purchased product	8	88.00%
9	BOD5 concentration in the purchased product (mg/L)	9	572,000
10	96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10	10,800
11	48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11	14,000
12	Aquatic toxicity (LC50) for other organisms (mg/L)	12	
13	Name of other test organism	13	Test
14	Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14	42,000
15	Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15	20,700
16	Typical application strength of purchased deicer (100% = no dilution of purchased product)	16	50%
17	Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17	21,000
18	Cost of aircraft deicer at purchased concentration ($/gallon)	18	$8.63

Deicer Collection and Storage

19	Do you collect deicing runoff for storage and treatment?	19	YES / NO
20	Collection technique	20	Apron drainage diversion (20-50%)
21	Estimated collection efficiency (percent of applied glycol)	21	46%
22	Estimated losses of uncollected deicer fluid (percent of applied glycol)	22	30%

	Treatment Information		Flow	BOD5	COD
23	Maximum daily amount accepted for treatment	23	0.2	1200	
24	Units	24	CFS	LB/D	N/A
25	Unit cost	25	0.0059	$0.25	

Tools and Models

26	Have other water quality tools or models been applied to your site?	26	YES / NO

KNOWN PROBLEMS

Exceedances of Permit Limits

27	Do you periodically exceed your concentration limits for BOD5 or COD?	27	YES / NO
			BOD5 / COD
28	If so, what is the highest observed daily concentration? (mg/L)	28	140
29	Do you exceed daily load limits for BOD5 or COD?	29	YES / NO
			BOD5 / COD
30	If so, what is the highest observed daily load? (lbs/day)	30	600

Other Known Problems

31	Are there known negative environmental consequences of deicing discharges?	31	YES / NO
	Description of the negative environmental consequence (optional)		

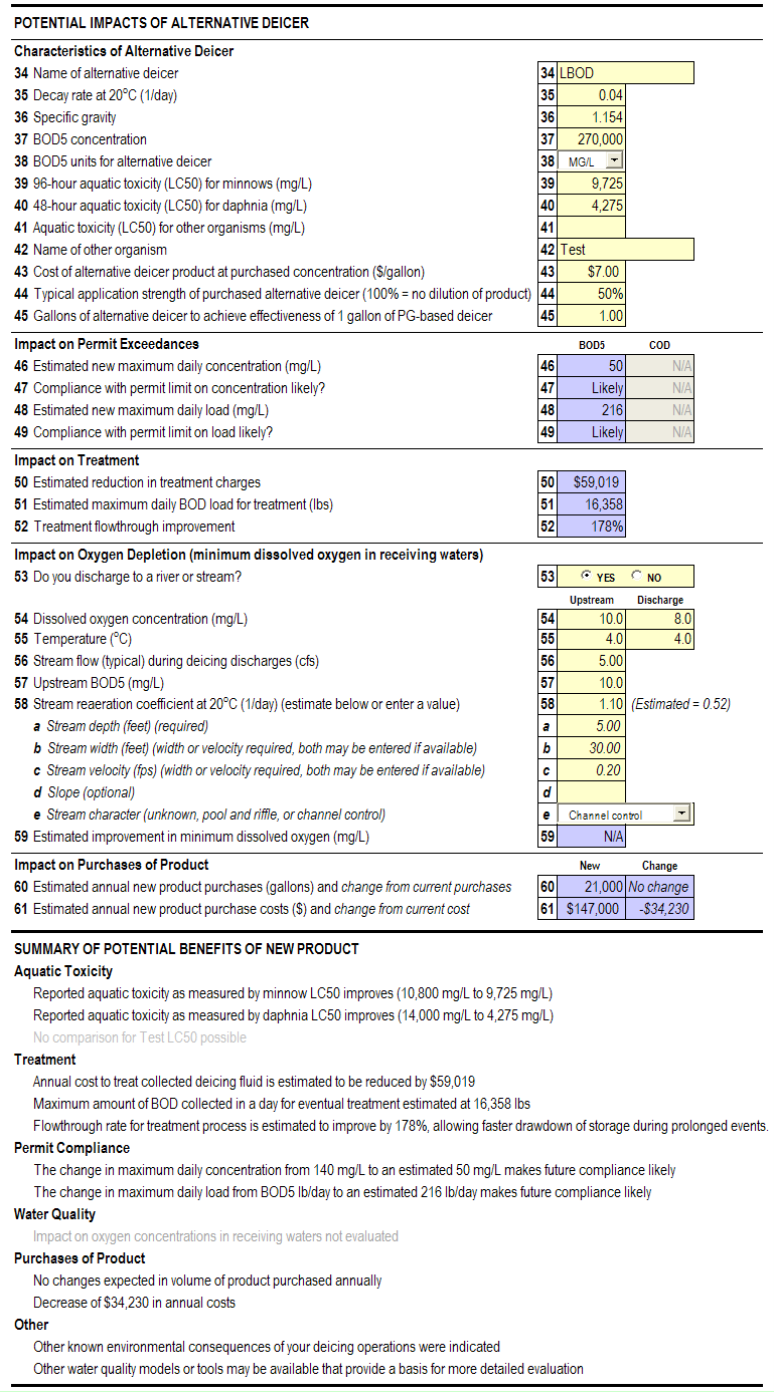
Treatment Issues

32	Are costs of treatment for collected deicer fluid excessive?	32	YES / NO
33	Is existing treatment and onsite storage capacity adequate for needs?	33	YES / NO

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Figure 4. PDX Evaluation

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet PDX.xls, to better view the decision support tool inputs on a computer screen.



POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Characteristics of Alternative Deicer				
34 Name of alternative deicer	34	LBOD		
35 Decay rate at 20°C (1/day)	35	0.04		
36 Specific gravity	36	1.154		
37 BOD5 concentration	37	270,000		
38 BOD5 units for alternative deicer	38	MG/L		
39 96-hour aquatic toxicity (LC50) for minnows (mg/L)	39	9,725		
40 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	40	4,275		
41 Aquatic toxicity (LC50) for other organisms (mg/L)	41			
42 Name of other organism	42	Test		
43 Cost of alternative deicer product at purchased concentration ($/gallon)	43	$7.00		
44 Typical application strength of purchased alternative deicer (100% = no dilution of product)	44	50%		
45 Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	45	1.00		
Impact on Permit Exceedances		BOD5	COD	
46 Estimated new maximum daily concentration (mg/L)	46	50	N/A	
47 Compliance with permit limit on concentration likely?	47	Likely	N/A	
48 Estimated new maximum daily load (mg/L)	48	216	N/A	
49 Compliance with permit limit on load likely?	49	Likely	N/A	
Impact on Treatment				
50 Estimated reduction in treatment charges	50	$59,019		
51 Estimated maximum daily BOD load for treatment (lbs)	51	16,358		
52 Treatment flowthrough improvement	52	178%		
Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)				
53 Do you discharge to a river or stream?	53	YES / NO		
		Upstream	Discharge	
54 Dissolved oxygen concentration (mg/L)	54	10.0	8.0	
55 Temperature (°C)	55	4.0	4.0	
56 Stream flow (typical) during deicing discharges (cfs)	56	5.00		
57 Upstream BOD5 (mg/L)	57	10.0		
58 Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)	58	1.10	*(Estimated = 0.52)*	
a Stream depth (feet) (required)	a	5.00		
b Stream width (feet) (width or velocity required, both may be entered if available)	b	30.00		
c Stream velocity (fps) (width or velocity required, both may be entered if available)	c	0.20		
d Slope (optional)	d			
e Stream character (unknown, pool and riffle, or channel control)	e	Channel control		
59 Estimated improvement in minimum dissolved oxygen (mg/L)	59	N/A		
Impact on Purchases of Product		New	Change	
60 Estimated annual new product purchases (gallons) and *change from current purchases*	60	21,000	*No change*	
61 Estimated annual new product purchase costs ($) and *change from current cost*	61	$147,000	*-$34,230*	

SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT

Aquatic Toxicity
- Reported aquatic toxicity as measured by minnow LC50 improves (10,800 mg/L to 9,725 mg/L)
- Reported aquatic toxicity as measured by daphnia LC50 improves (14,000 mg/L to 4,275 mg/L)
- No comparison for Test LC50 possible

Treatment
- Annual cost to treat collected deicing fluid is estimated to be reduced by $59,019
- Maximum amount of BOD collected in a day for eventual treatment estimated at 16,358 lbs
- Flowthrough rate for treatment process is estimated to improve by 178%, allowing faster drawdown of storage during prolonged events.

Permit Compliance
- The change in maximum daily concentration from 140 mg/L to an estimated 50 mg/L makes future compliance likely
- The change in maximum daily load from BOD5 lb/day to an estimated 216 lb/day makes future compliance likely

Water Quality
- Impact on oxygen concentrations in receiving waters not evaluated

Purchases of Product
- No changes expected in volume of product purchased annually
- Decrease of $34,230 in annual costs

Other
- Other known environmental consequences of your deicing operations were indicated
- Other water quality models or tools may be available that provide a basis for more detailed evaluation

Figure 4. PDX Evaluation (continued)

These figures are screen captures of the working decision support tool that may be difficult to read at this size printed out or on a computer screen. Larger-size copies of these figures are included in Attachment 2 for printing on tabloid (11"x17") paper; users may elect to open the accompanying spreadsheet, Evaluation Worksheet PDX.xls, to better view the decision support tool inputs on a computer screen.

As noted above, there has been a significant amount of work done at PDX on the subject of deicing, including development of an existing detailed airfield loading and deicing discharge model for the facility. This model includes not only predictions of deicer usage as a function of weather, but also the fate and transport of deicing runoff through the airport's deicing runoff management system. The system consists of a series of diversion valves that route deicing runoff to three different destinations depending on deicer concentration: 1) concentrated storage tank (CST) where high-BOD runoff is held for discharge to a POTW; 2) dilute detention basin (DDB) where medium strength deicing runoff is held to be metered into the receiving water in accordance with the airport's NPDES permit daily load limits; and 3) direct discharge to the receiving waters. The complexity of this system was not, of course, represented in the Decision Support Tool depiction of PDX.

The PDX airfield loading model provided the opportunity to conduct an separate evaluation of the implications of switching from a conventional PG-based ADF product to an alternative product. The model was configured to reflect the current deicing runoff management system at PDX and a switch to an ADF having characteristics similar to LBOD ADF. The results were compared to the output of the Decision Support Tool.

Table 1. PDX Airfield Model Results

Scenario	ADF BOD (mg/L)	ADF Factor	Storage (CST and DDB)	Overflow events	Total Overflow Volume	Total BOD mass (tons)
Baseline configuration - Standard ADF						
	570,000	1.46	2 MG + 12 MG	83	1,412 MG	2,184
Baseline configuration - New ADF						
	320,000	0.82	2 MG + 12 MG	57	1,082 MG	1,425
Standard ADF + Added Storage to match events (+10.5 MG)						
	570,000	1.46	4 MG + 20.5 MG	57	1,050 MG	1,814

The PDX airfield model was run under a typical winter season scenario to assess the impacts of changing the type of ADF used at the facility. Results from analysis of three different scenarios are shown in Table 1, as can be summarized as follows:

- Baseline configuration: The PDX airfield model was applied with the current storage configuration of 2 MG in the Concentrated Storage Tank (CST) and 12 MG in the Dilute Detention Basin (DDB), and standard aircraft deicing fluid with a BOD concentration of 570,000 mg/L. The ADF factor, which adjusts ADF usage in terms of BOD, was set to 1.46 to reflect expected growth of 46% over

current traffic. The simulation showed 83 storage overflow events over the 42-year simulation period that could potentially result in permit exceedances.

- New ADF: The model was applied with the same storage configuration, but with the ADF factor set to 0.82 to simulate the reduced BOD concentration of a new ADF formulation. The model indicated that only 57 storage overflow events were expected under the same conditions as for the baseline run.

- Added Storage: Concentrated and dilute storage were increased iteratively until the number of overflow events predicted with current ADF formulations matched the number of events predicted in the "New ADF" scenario. CST storage was increased to 4 MG and DDB storage was increased to 20.5 MG to achieve this match, a total increase of 10.5 MG in on-site storage.

The results of these analyses suggest that use of an alternative ADF could provide a water quality benefit equivalent to adding a total of 10.5 MG of additional storage at PDX.

A comparison of results between the Decision Support Tool and the airfield loading model yields the following observations:

- The evaluation of changes in storage requirements as a function of an alternative ADF is beyond the capabilities of the Decision Support Tool, which does not provide mechanisms for evaluation of storage size needs.

- The Decision Support Tool analysis suggests that permit compliance is likely using the new ADF. Although the detailed airfield model predicts improved compliance, the probability of non-compliance events remains significant. The discrepancy in these results reflects differences in the level of sophistication in the analyses. The PDX deicing runoff control system is both complex in its configuration and dynamic in its operation. The Decision Support Tool simply cannot represent these subtleties in its screening-level portrayal of the system.

3.2 REVIEW AND FEEDBACK

As part of the case studies development, feedback was sought from the airfield and airport representatives on the Decision Support Tool.

The functionality of the tool was judged as acceptable. The representatives indicated that the tool provided a convenient and user friendly means of evaluating general operational implications of a theoretical change in deicing fluid used at their facility. The following specific recommendations were provided for improving the utility of the Decision Support Tool to their situations:

1. A higher level of detailed analysis for evaluating operations at a finer temporal scale. For example, LTC Tower indicated that runoff diversion valves are sometimes managed to provide for the capture of the initial 0.1 inch of runoff (i.e. first flush) and that subsequent runoff may be routed to a different location.

2. Capability for including other deicing materials in the analyses and subsequent evaluation of implications for storage and discharge requirements. Both ANG representatives indicated that pavement chemicals can be of concern to their collection and discharge operations and that the ability to include these materials in the analyses would be helpful.

3. Include consideration of deicing material storage, shelf life, and delivery/refill implications based on estimated changes in volume of purchased product.

4. Instructions were generally characterized as appropriate and helpful. Some of the line item text in the worksheet was changed to reflect clarifying suggestions with respect to terminology, and the instructions were expanded with additional discussions of sources for default data and of temperature impacts on measurements and calculations.

The first three items are not incorporated in this version of the evaluation worksheet. The suggestions are acknowledged as being of value for environmental management personnel at air facilities, but are outside of the objective for this immediate effort, which is to provide a generalized tool that is widely applicable for screening purposes. The additional functionality requested may be considered in any future enhancements that may be considered for the Decision Support Tool.

4. SUMMARY

A Decision Support Tool was developed to provide a means for environmental management personnel to evaluate the implications of changing aircraft deicer fluid from a conventional propylene glycol based product to an alternative product. The tool was configured using data from three facilities, the Bangor ANG facility in Bangor, Maine, the Pittsburgh ANG facility in Pittsburgh, PA, and Portland International Airport, in Portland, Oregon. The data from these facilities is representative of a range of operational sizes and deicing fluid usage rates.

Testing of the Decision Support Tool using data provided by PIT, BNG, and PDX indicated a range of benefits to the facilities realized through a switch from a convention PG-based ADF to an alternative product. Decreased toxicity, treatment costs, and annual purchase costs were predicted for all three facilities. Improved permit compliance was predicted at PDX by the Tool and an independent evaluation using the existing airfield model, although the tool provided a significantly more optimistic projection. This observation emphasizes the fact that the Decision Support Tool results should be understood to be simplified, screening-level predictions.

The tool was reviewed with environmental management personnel at each of the facilities. Feedback on the ease of use and general utility of the tool was positive from all three individuals interviewed. Suggestions for increasing the value of the tool were provided but the implementation of those suggestions was outside the scope of this effort. Specific recommendations included the following:

- Adding provisions for a higher level of detailed analysis would be useful for evaluating operations at a finer temporal scale to allow for the evaluation of operational strategies on storage and discharge characteristics, and

- Additional algorithms to allow for the evaluation of potential influences of pavement deicing materials on storage and discharge requirements.

The review process indicated that the Decision Support Tool, as developed, provides airport environmental personnel with a convenient means for evaluating the implications of changing the type of aircraft deicing fluid used at a facility.

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ATTACHMENT 1

Decision Support Tool Instructions

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Instructions
Evaluation Worksheet for Alternative Aircraft Deicers

Overview

The potential environmental impacts of stormwater runoff that contains aircraft deicing chemicals is a serious concern to state and federal environmental regulators. The primary concerns center on elevated biochemical oxygen demand (BOD) in stormwater discharges that may cause reduced dissolved oxygen in the receiving streams, and toxicity to aquatic organisms from additives that are required to meet SAE fluid performance specifications.

Research and product development efforts by the ADF manufacturers, the U.S. Government, and others are resulting in the introduction of reformulated and new aircraft deicing fluids (ADFs) with improved environmental characteristics. These new products are entering the marketplace on a regular basis, with properties that represent potentially significant improvements over older ADF formulations. However, the actual benefits that a new formulation will provide at a base or airport depends on many facility-specific factors. Thus, an evaluation is needed to confirm that the improved environmental characteristics of the product are actually likely to make a difference in the specific operational and regulatory context of the facility.

This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory compliance, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF currently in use. The evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions regarding a switch to the new formulation.

It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

The tool has been laid out in a format similar to many IRS forms and therefore should be familiar to most people. The tool is generally self-explanatory, with instructions provided below to ensure that the user has a clear understanding of the information that is required to fill out the tool, and can appropriately interpret the evaluation output. You may save the file under a unique name to archive the analysis, and print out the form for your records.

General Instructions

This evaluation worksheet is provided as a Microsoft Excel workbook to be filled out on your computer. All information is to be entered into the boxes shaded yellow. Results calculated from the information you have entered will be displayed in boxes shaded light blue. Certain fixed information, such as the concentration of BOD_5 in 100% propylene glycol, is shown in boxes shaded gray.

Specific instructions are presented below for the different sections of the worksheet.

FACILITY INFORMATION

This section identifies the site for which an alternative aircraft deicing material or method is being considered, and ensures that the documentation will be complete for the user's files. Please enter information as accurately as possible to ensure that the documentation for your files is complete.

CURRENT SITUATION

This section describes current practices, aircraft deicers used, and other relevant information about your site.

NPDES Storm Water Permit Information

If your facility is operating under a permit that authorizes discharge of deicing runoff, please provide the following information. Note: If you do not hold a permit for stormwater discharges containing deicing materials, and deicing is conducted at your facility, a compliance assessment may be advisable.

Line 1 – Does your site have an NPDES Storm Water permit for discharge of deicing runoff? Mark Yes or No.

Line 2 – NPDES permit number. Enter permit number from your NPDES permit.

Line 3 – Permitting authority. Enter the name of the permitting authority that issues your permit.

Line 4 – Most stringent permitted discharge concentration (mg/L). Enter the most stringent permitted concentration limit applicable during periods of peak deicing. If no limit is specified in the permit, leave the line blank.

Line 5 – Most stringent permitted maximum daily load (lbs/day). Enter the most stringent permitted daily load limit applicable during periods of peak deicing.

Current Type I Deicer Information

This subsection describes characteristics of the aircraft deicer fluid currently in use at your site as well as application practices and usage. Product characteristics are often provided in the product material safety data sheet (MSDS) or other manufacturer literature.

Line 6 – BOD_5 Decay rate at 20°C (1/day). This value describes the rate at which biological oxygen demand – associated with the chemicals in the aircraft deicer fluid – is reduced following application. This information is typically not provided for existing deicers, so a default value is provided that is based on ESTCP lab measurements. This default value of 0.18/day can be changed if you have decay rate information specific to your existing purchased aircraft deicer product. The value supplied for 20°C is temperature-corrected for calculations according to standard methods.

Line 7 – BOD_5 concentration of propylene glycol (mg/L). A constant value of 650,000 mg/L has been provided that is representative of industry norms. This default can be changed if you have product-specific information.

Line 8 – Percent glycol in purchased product. Enter the percent propylene glycol in your purchased product as described in the MSDS on the label.

Line 9 – BOD_5 concentration in the purchased product (mg/L). The BOD_5 concentration in your purchased product is calculated from the information in Line 7 and Line 8. The calculated value will change to reflect product-specific information you may enter.

Line 10 – 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L). Enter the concentration reported for your purchased product, if available.

Line 11 – 48-hour aquatic toxicity (LC50) for daphnia (mg/L). Enter the concentration reported for your purchased product, if available.

Line 12 – Aquatic toxicity (LC50) for other organisms (mg/L). Enter the concentration reported for your purchased product, if available.

Line 13 – Name of other organism. If you entered information on Line 12 about aquatic toxicity results for an organism other than fathead minnows or daphnia, enter the name of the organism here.

Line 14 – Annual volume of applied aircraft deicer mixture (gallons at working concentration). Enter annual gallons applied to aircraft at working concentrations (e.g. total gallons sprayed) in a typical or average year.

Line 15 – Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration). Enter the maximum daily total of gallons applied to aircraft at working concentrations (e.g. most gallons sprayed in a day). The maximum daily total should not exceed the typical annual volume in Line 14.

Line 16 – Typical application strength of purchased deicer (100% = no dilution of purchased product). Enter a percentage that reflects the strength at which you apply your purchased deicer. This is NOT the glycol concentration of the deicer! For example, if you purchase pre-mixed deicer at working concentration that is ready for application, enter 100%; if you mix equal parts of purchased concentrated product and water to get working concentration prior to application, enter 50%.

Line 17 – Calculated annual volume of aircraft deicer at purchased concentration (gallons). The typical annual volume purchased is calculated from the information entered in Line 14 and Line 16.

Line 18 – Cost of aircraft deicer at purchased concentration ($/gallon). Enter the price you pay per gallon for purchased aircraft deicer product.

Deicer Collection and Storage

At many airfields, deicing runoff is collected for recycling or treatment.

Line 19 – Do you collect deicing runoff for storage and treatment? If you collect deicing runoff for storage and treatment, mark "Yes". Otherwise, mark "No".

Line 20 – Collection Technique. Select the appropriate collection technique used at your airfield. The techniques included in this entry are presented with a typical range of collection efficiencies for the techniques:

Designated deicing pads: 50 – 70%

Sweeper-vacs: 25 – 35%

Apron drainage diversion during deicing: 20 - 50%

Other: 0% - 100%

Line 21 – Estimated collection efficiency (percent of applied glycol). Enter the average percentage of applied aircraft deicing mixture that is collected for storage and treatment during the deicing season. For example, if you apply deicing fluid that contains a total of 10,000 gallons of glycol, and collect runoff containing 6,500 gallons of glycol for treatment/ disposal during a season, enter 65%. If you do not have facility data on collection, use the guidelines provided under Line 20 to roughly estimate your collection efficiency. The sum of the collection efficiency and the estimated losses in Line 22 should not add up to more than 100%.

Line 22 – Estimated losses of uncollected deicer fluid (percent of applied glycol). A constant loss rate of 30% has been specified to account for deicer fluid that is not collected and does not reach your receiving water (if any).

Treatment Information

Treatment may consist of onsite processes or conveyance to an offsite treatment plant.

Line 23 – Maximum daily amount accepted for treatment. Enter any daily limits on flow or mass of BOD5 or COD for your treatment process or offsite conveyance.

Line 24 – Units. Indicate units for the limits, if any, specified in line 23.

Line 25 – Unit cost. Enter the unit cost assessed to you for treatment.

Tools and Models

This worksheet provides a screening-level evaluation of operational and environmental impacts from deicing activities. More detailed previous studies, if available, may support more nuanced evaluations or identify other areas of concern.

Line 26 – Have other WQ tools or models been applied to your site? If other water quality assessments have been done, or other water quality models applied for evaluation of impacts of deicing activities at your site, mark "Yes". Otherwise, mark "No".

KNOWN PROBLEMS

This section allows you to enter information characterizing some problems that are common to many facilities that deice aircraft. Not all problem areas may be relevant to your site.

Exceedances of Permit Limits

Continuing exceedance of load or concentration limits in a discharge permit may lead to fines or other enforcement actions.

Line 27 – Do you periodically exceed your concentration limits for BOD_5 or COD? If your monitoring data for discharge limits shows concentrations above your permit limits, mark "Yes".

Line 28 – If so, what is the highest observed daily concentration? (mg/L). If concentration limits are exceeded, enter the highest observed concentration from your monitoring data.

Line 29 – Do you exceed daily load limits for BOD_5 or COD? If your monitoring data for discharge limits shows loads above your permit limits, mark "Yes".

Line 30 – If so, what is the highest observed daily load? (lbs/day). If load limits are exceeded, enter the highest observed load from your monitoring data.

Other Known Problems

This evaluation worksheet addresses only certain common issues. You may have site-specific issues not covered herein.

Line 31 – Are there known negative environmental consequences? Mark "Yes" or "No". Some examples of negative consequences would be fish kills, odor complaints, or growths of attached bacteria at outfalls.

Treatment Issues

Treatment issues considered in this worksheet are annual cost of treatment and treatment capacity.

Line 32 – Are costs of treatment for collected deicer fluid excessive? Mark "Yes" if costs associated with treatment of collected aircraft deicer fluid are a burden for your facility.

Line 33 – Is existing treatment and onsite storage capacity adequate for needs? Mark "Yes" if your treatment system and onsite storage capacities are generally sufficient to handle the volume of collected aircraft deicer fluid.

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

This is where you describe the properties of the alternative deicer under consideration and develop a screening-level assessment of a potential change to use of the alternative deicer.

Characteristics of Alternative Deicer

This section describes the properties of the alternative deicer under consideration.

Line 34 – Name of alternative deicer. Enter name of product under consideration.

Line 35 – BOD_5 decay rate at 20°C (1/day). Enter the decay rate reported in product literature.

Line 36 – Specific gravity. Enter the specific gravity of the alternative product.

Line 37 – BOD_5 concentration (mg/kg). Enter the BOD_5 concentration reported for the alternative deicer as purchased.

Line 38 – Units for alternative deicer for BOD_5. Indicate the units used for the concentration reported in Line 37.

Line 39 – 96-hour aquatic toxicity (LC50) for fathead minnows (mg/L). Enter the concentration reported for the alternative deicer named in Line 34.

Line 40 – 48-hour aquatic toxicity (LC50) for daphnia (mg/L). Enter the concentration reported for the alternative deicer named in Line 34.

Line 41 – Aquatic toxicity (LC50) for other organisms (mg/L). Enter the concentration reported for the alternative deicer named in Line 34.

Line 42 – Name of other organism. If you entered information on Line 41 about aquatic toxicity results for an organism other than fathead minnows or daphnia, enter the name of the organism here.

Line 43 - Cost of alternative deicer product at purchased concentration ($/gallon). Enter the price you will pay per gallon for the alternative deicer product named in Line 34.

Line 44 – Strength of purchased alternative deicer at which you will apply (100% = no dilution of product). Enter a percentage that reflects the strength at which you will apply your alternative deicer. For example, if you will apply the alternative deicer product undiluted, enter 100%; if you mix equal parts of product and water for application, enter 50%.

Line 45 – Gallons of alternative deicer equivalent to effectiveness of 1 gallon PG-based deicer. This line measures the effectiveness of the alternative deicer relative to propylene glycol. For example, if it is necessary to only apply 9 gallons of an alternative deicer mixture to achieve the same result as 10 gallons of a propylene glycol-based mixture, enter 0.9 (9/10).

Impact on Permit Exceedances

If permit exceedances were identified as a known problem at your site, this worksheet estimates new discharge concentrations and loads based on the alternative deicer characteristics.

Line 46 – Estimated new maximum daily concentration (mg/L). If applicable, the worksheet estimates a maximum discharge concentration using alternative deicer.

Line 47 – Compliance with permit limit on concentration likely? If applicable, the worksheet presents a qualitative assessment of the likelihood of compliance with reported permit limits. If the new estimated concentration from Line 46 is greater than the permit limit reported in Line 4, compliance is reported as "Not Likely". If the new concentration is 20% or more lower than the permit limit, compliance is reported as "Likely". Otherwise, compliance is "Possible".

Line 48 – Estimated new maximum daily load (mg/L). If applicable, the worksheet estimates a maximum discharge load using the alternative deicer.

Line 49 – Compliance with permit limit on load likely? If applicable, the worksheet presents a qualitative assessment of the likelihood of compliance with reported permit limits. If the new estimated load from Line 48 is greater than the permit limit reported in Line 5, compliance is reported as "Not Likely". If the new load is 20% or more lower than the permit limit, compliance is reported as "Likely". Otherwise, compliance is "Possible".

Impact on Treatment

If treatment costs or loads were identified as areas of concerns, the worksheet will provide simple estimates of potential changes in treatment costs and operations.

Line 50 – Estimated reduction in treatment charges. If applicable, the worksheet presents the estimated reduction in costs for treatment of collected aircraft deicing fluid.

Line 51 – Estimated maximum daily BOD_5 load for treatment (lbs). If applicable, the worksheet presents the estimated new maximum daily BOD_5 load for conveyance to treatment.

Line 52 – Treatment flowthrough improvement. If applicable, the worksheet presents an estimate of potential improvement in treatment process rates and volumes. This estimate assumes that the treatment process is mass-limited, and that a reduction in BOD_5 content of collected aircraft deicing fluid therefore may allow quicker treatment and therefore faster drawdown of storage. A ratio of 200% would indicate that treatment could occur twice as fast and that therefore twice as much volume could be processed in the same time.

Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)

For sites where deicing fluid reaches a river or stream as stormwater runoff, the worksheet can perform a simple estimate of dissolved oxygen dynamics in the receiving water. The worksheet looks at a critical condition corresponding to your maximum daily usage as reported in Line 15 and compares the resultant minimum dissolved oxygen levels in the receiving waters.

Line 53 – Do you discharge to a river or stream? Mark "Yes" only if deicing fluids from your site are discharges to a free-flowing stream or river. Discharges to lakes and estuaries are not evaluated in this worksheet.

Line 54 - Dissolved oxygen concentration (mg/L). Enter measured or estimated dissolved oxygen levels in the discharged stormwater and in the stream above the point of discharge. If site-specific data are not available, use 9.0 mg/L for upstream and 5.0 mg/L for discharge concentration.

Line 55 - Temperature (°C). Enter measured or estimated temperature in the discharged stormwater and in the stream above the point of discharge. If site-specific data are not available, use 9.0° for upstream and 5.0° for discharge temperature.

Line 56 - Stream flow (cfs). Enter measured or estimated streamflow above the point of discharge. Measured streamflow may be available from the U.S. Geological Survey (www.waterdata.usgs.gov); other estimation methods are discussed online (e.g. http://www.geog.umb.edu/wdripps/Fieldmethods/streamflow.doc).

Line 57 – Upstream BOD_5 (mg/L). Enter measured or estimated BOD_5 above the point of discharge. If site-specific data are not available, use 1.0 mg/L for upstream BOD_5

Line 58 – Stream reaeration coefficient at 20°C (1/day). Supply your own estimated value, or enter information about your stream in Lines 58a-e for the worksheet to calculate a reaeration coefficient.

Line 59 - Estimated improvement in minimum dissolved oxygen (mg/L). The worksheet calculates how much oxygen depletion (minimum instream dissolved oxygen) changes in this simple evaluation when the alternative aircraft deicer is used. A positive result is an improvement in oxygen concentrations; for example, a result of 4.5 mg/L means that the maximum amount of oxygen depletion was 4.5 mg/L less for the alternative product, and that minimum oxygen concentrations in the stream or river are therefore expected to be 4.5 mg/L higher.

There are a number of equations that can be used to estimate stream reaeration coefficients from more directly measureable characteristics such as flow depth and velocity. Some use more parameters than others, to achieve more reliable estimates. Further, these equations generally only apply to certain ranges of stream characteristics, that sometimes overlap. The worksheet uses all available information and chooses the most appropriate equation.

Line 58a – Stream depth. Enter the depth of the stream in feet. Stream depth is required.

Line 58b – Stream width. Enter the width of the stream in feet, if available. You must enter either the stream width or the stream velocity to get an estimate. Enter both if available to refine the estimate.

Line 58c – Stream velocity (fps). Enter the velocity of the stream in feet, if available. You must enter either the stream width or the stream velocity to get an estimate. Enter both parameters if available to refine the estimate.

Line 58d – Slope (optional). Enter the bottom slope of the stream if available to refine the estimate.
Line 58e – Stream character (unknown, pool and riffle, or channel control). If feasible, indicate if the stream is characterized by pools and riffles or instead is channel controlled (with uniform, often engineered, cross-sections).

Impact on Purchases of Product

Differences in strength or effectiveness of the alternative product may result in changes in purchase costs and amounts.

Line 60 - Estimated annual new product purchases (gallons) and change from current purchases. The worksheet estimates annual purchases of the alternative (new) deicer from your current usage by applying application dilution information and relative effectiveness. The estimated new purchase amount and the change in volume from the current purchase amount are both shown.

Line 61 - Estimated annual new product purchase costs ($) and change from current costs. The worksheet estimates annual purchase costs of the alternative (new) deicer by applying the cost information you have provided in Line 18 and Line 42 to the annual purchase volumes estimated in Line 17 and Line 59. The estimated new purchase cost and the change from the current purchase cost are both shown.

SUMMARY

The Summary section presents brief qualitative assessments of potential impacts related to the use of the alternative deicer fluid compared to conventional Type I ADF. Assessments are presented by the following categories of potential impact or change:

Aquatic Toxicity – The change in the toxicity of Type I deicer to test organisms for which LC50s have been entered. An increased LC50 number represents decreased toxicity.

Treatment – Assessments of the implications to the treatment of collected deicing runoff. Aspects include how quickly collected runoff can be discharged to treatment, and cost of treatment.

Permit Compliance – Provides an assessment of the likelihood of permit compliance with concentration and/or load limits.

Water Quality – Assesses likely impacts on dissolved oxygen in the receiving stream based on the simple spreadsheet analysis.

Purchases of Product – Assesses likely implications to cost of purchased deicer.

Other – Provides comments on the presence of additional issues, and additional modeling analyses that may be worth conducting.

ATTACHMENT 2

Additional Figures

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EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS

This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory compliance, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF currently in use. The evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions regarding a switch to the new formulation.

It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

SITE INFORMATION

Site Name	
Address	
Person filling out form	
E-mail Address	Telephone Number

CURRENT SITUATION

NPDES Storm Water Permit Information

1	Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1	YES / NO
2	NPDES permit number	2	
3	Permitting authority	3	
	Permit limits during periods of peak deicing activity		BOD5 / COD
4	Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4	
5	Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5	

Current Type I Deicer Information (See MSDS and manufacturer's literature)

			Type I
6	Decay rate at 20°C (1/day)	6	0.18
7	BOD5 concentration of propylene glycol (mg/L)	7	650,000
8	Percent glycol in purchased product	8	
9	BOD5 concentration in the purchased product (mg/L)	9	0
10	96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10	
11	48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11	
12	Aquatic toxicity (LC50) for other organisms (mg/L)	12	
13	Name of other test organism	13	
14	Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14	
15	Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15	
16	Typical application strength of purchased deicer (100% = no dilution of purchased product)	16	
17	Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17	0
18	Cost of aircraft deicer at purchased concentration ($/gallon)	18	

Deicer Collection and Storage

19	Do you collect deicing runoff for storage and treatment?	19	YES / NO
20	Collection technique	20	Other (0% - 100%)
21	Estimated collection efficiency (percent of applied glycol)	21	0%
22	Estimated losses of uncollected deicer fluid (percent of applied glycol)	22	30%

Treatment Information

			Flow	BOD5	COD
23	Maximum daily amount accepted for treatment	23			
24	Units	24	N/A	LB/D	N/A
25	Unit cost	25			

Tools and Models

26	Have other water quality tools or models been applied to your site?	26	YES / NO

KNOWN PROBLEMS

Exceedances of Permit Limits

27	Do you periodically exceed your concentration limits for BOD5 or COD?	27	YES / NO
			BOD5 / COD
28	If so, what is the highest observed daily concentration? (mg/L)	28	
29	Do you exceed daily load limits for BOD5 or COD?	29	YES / NO
			BOD5 / COD
30	If so, what is the highest observed daily load? (lbs/day)	30	

Other Known Problems

31	Are there known negative environmental consequences of deicing discharges?	31	YES / NO

Description of the negative environmental consequence (optional)

Treatment Issues

32	Are costs of treatment for collected deicer fluid excessive?	32	YES / NO
33	Is existing treatment and onsite storage capacity adequate for needs?	33	YES / NO

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Figure 1. Evaluation Worksheet for Alternative Deicer Fluids

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Characteristics of Alternative Deicer

34	Name of alternative deicer	
35	Decay rate at 20°C (1/day)	
36	Specific gravity	
37	BOD5 concentration	
38	BOD5 units for alternative deicer	MG/L
39	96-hour aquatic toxicity (LC50) for minnows (mg/L)	
40	48-hour aquatic toxicity (LC50) for daphnia (mg/L)	
41	Aquatic toxicity (LC50) for other organisms (mg/L)	
42	Name of other organism	
43	Cost of alternative deicer product at purchased concentration ($/gallon)	
44	Typical application strength of purchased alternative deicer (100% = no dilution of product)	
45	Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	

Impact on Permit Exceedances

		BOD5	COD
46	Estimated new maximum daily concentration (mg/L)	N/A	N/A
47	Compliance with permit limit on concentration likely?	N/A	N/A
48	Estimated new maximum daily load (mg/L)	N/A	N/A
49	Compliance with permit limit on load likely?	N/A	N/A

Impact on Treatment

50	Estimated reduction in treatment charges	
51	Estimated maximum daily BOD load for treatment (lbs)	
52	Treatment flowthrough improvement	

Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)

53	Do you discharge to a river or stream?	(•) YES ( ) NO		
		Upstream	Discharge	
54	Dissolved oxygen concentration (mg/L)			
55	Temperature (°C)			
56	Stream flow (typical) during deicing discharges (cfs)			
57	Upstream BOD5 (mg/L)			
58	Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)			*(Estimate not available)*
	a *Stream depth (feet) (required)*			
	b *Stream width (feet) (width or velocity required, both may be entered if available)*			
	c *Stream velocity (fps) (width or velocity required, both may be entered if available)*			
	d *Slope (optional)*			
	e *Stream character (unknown, pool and riffle, or channel control)*	Unknown		
59	Estimated improvement in minimum dissolved oxygen (mg/L)	N/A		

Impact on Purchases of Product

		New	Change
60	Estimated annual new product purchases (gallons) and *change from current purchases*		
61	Estimated annual new product purchase costs ($) and *change from current cost*		

SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT

Aquatic Toxicity

No comparison for minnow LC50 possible

No comparison for daphnia LC50 possible

No comparison for 0 LC50 possible

Treatment

Annual cost to treat collected deicing fluid is estimated to be reduced by

Maximum amount of BOD collected in a day for eventual treatment estimated at lbs

Flowthrough rate for treatment process is estimated to improve by , allowing faster drawdown of storage during prolonged events.

Permit Compliance

Compliance with permit limits for maximum daily concentration not evaluated

Compliance with permit limits for maximum daily loads not evaluated

Water Quality

Impact on oxygen concentrations in receiving waters not evaluated

Purchases of Product

Other

Other known environmental consequences of your deicing operations were indicated

Other water quality models or tools may be available that provide a basis for more detailed evaluation

Figure 1. Evaluation Worksheet for Alternative Deicer Fluids (continued)

EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS

This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory compliance, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF currently in use. The evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions regarding a switch to the new formulation.

It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

SITE INFORMATION

Site Name	Pittsburgh ANG
Address	
Person filling out form	Chris Cieciek, LimnoTech on behalf of LTC John Towers
E-mail Address	cciecick@limno.com
Telephone Number	

CURRENT SITUATION

NPDES Storm Water Permit Information

1	Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1	(•) YES ( ) NO
2	NPDES permit number	2	
3	Permitting authority	3	
	Permit limits during periods of peak deicing activity		BOD5 / COD
4	Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4	
5	Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5	

Current Type I Deicer Information (See MSDS and manufacturer's literature)

			Type I
6	Decay rate at 20°C (1/day)	6	0.18
7	BOD5 concentration of propylene glycol (mg/L)	7	650,000
8	Percent glycol in purchased product	8	88.00%
9	BOD5 concentration in the purchased product (mg/L)	9	572,000
10	96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10	10,800
11	48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11	14,000
12	Aquatic toxicity (LC50) for other organisms (mg/L)	12	
13	Name of other test organism	13	Test
14	Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14	25,000
15	Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15	6,250
16	Typical application strength of purchased deicer (100% = no dilution of purchased product)	16	50%
17	Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17	12,500
18	Cost of aircraft deicer at purchased concentration ($/gallon)	18	$8.63

Deicer Collection and Storage

19	Do you collect deicing runoff for storage and treatment?	19	(•) YES ( ) NO
20	Collection technique	20	Sweeper vacs (25-35%)
21	Estimated collection efficiency (percent of applied glycol)	21	29%
22	Estimated losses of uncollected deicer fluid (percent of applied glycol)	22	30%

Treatment Information

			Flow	BOD5	COD
23	Maximum daily amount accepted for treatment	23			
24	Units	24	GPM	LB/D	N/A
25	Unit cost	25	0.22		

Tools and Models

26	Have other water quality tools or models been applied to your site?	26	( ) YES (•) NO

KNOWN PROBLEMS

Exceedances of Permit Limits

27	Do you periodically exceed your concentration limits for BOD5 or COD?	27	( ) YES (•) NO
			BOD5 / COD
28	If so, what is the highest observed daily concentration? (mg/L)	28	140
29	Do you exceed daily load limits for BOD5 or COD?	29	( ) YES (•) NO
			BOD5 / COD
30	If so, what is the highest observed daily load? (lbs/day)	30	700

Other Known Problems

31	Are there known negative environmental consequences of deicing discharges?	31	( ) YES (•) NO

Description of the negative environmental consequence (optional)

Treatment Issues

32	Are costs of treatment for collected deicer fluid excessive?	32	( ) YES (•) NO
33	Is existing treatment and onsite storage capacity adequate for needs?	33	(•) YES ( ) NO

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Figure 2. Pittsburgh ANG Evaluation

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Characteristics of Alternative Deicer			
34 Name of alternative deicer	**34**	LBOD	
35 Decay rate at 20°C (1/day)	**35**	0.04	
36 Specific gravity	**36**	1.154	
37 BOD5 concentration	**37**	270,000	
38 BOD5 units for alternative deicer	**38**	MG/L	
39 96-hour aquatic toxicity (LC50) for minnows (mg/L)	**39**	9,725	
40 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	**40**	4,275	
41 Aquatic toxicity (LC50) for other organisms (mg/L)	**41**		
42 Name of other organism	**42**	Test	
43 Cost of alternative deicer product at purchased concentration ($/gallon)	**43**	$7.00	
44 Typical application strength of purchased alternative deicer (100% = no dilution of product)	**44**	50%	
45 Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	**45**	1.00	
Impact on Permit Exceedances		BOD5	COD
46 Estimated new maximum daily concentration (mg/L)	**46**	N/A	N/A
47 Compliance with permit limit on concentration likely?	**47**	N/A	N/A
48 Estimated new maximum daily load (mg/L)	**48**	N/A	N/A
49 Compliance with permit limit on load likely?	**49**	N/A	N/A
Impact on Treatment			
50 Estimated reduction in treatment charges	**50**	$22,147	
51 Estimated maximum daily BOD load for treatment (lbs)	**51**	3,114	
52 Treatment flowthrough improvement	**52**	178%	
Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)			
53 Do you discharge to a river or stream?	**53**	YES / NO	
		Upstream	Discharge
54 Dissolved oxygen concentration (mg/L)	**54**	9.0	5.0
55 Temperature (°C)	**55**	5.0	2.0
56 Stream flow (typical) during deicing discharges (cfs)	**56**	5.00	
57 Upstream BOD5 (mg/L)	**57**	1.0	
58 Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)	**58**		*(Estimate not available)*
a *Stream depth (feet) (required)*	***a***		
b *Stream width (feet) (width or velocity required, both may be entered if available)*	***b***		
c *Stream velocity (fps) (width or velocity required, both may be entered if available)*	***c***		
d *Slope (optional)*	***d***		
e *Stream character (unknown, pool and riffle, or channel control)*	***e***	Unknown	
59 Estimated improvement in minimum dissolved oxygen (mg/L)	**59**	N/A	
Impact on Purchases of Product		New	Change
60 Estimated annual new product purchases (gallons) and *change from current purchases*	**60**	12,500	*No change*
61 Estimated annual new product purchase costs ($) and *change from current cost*	**61**	$87,500	*-$20,375*

SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT

Aquatic Toxicity

Reported aquatic toxicity as measured by minnow LC50 improves (10,800 mg/L to 9,725 mg/L)

Reported aquatic toxicity as measured by daphnia LC50 improves (14,000 mg/L to 4,275 mg/L)

No comparison for Test LC50 possible

Treatment

Annual cost to treat collected deicing fluid is estimated to be reduced by $22,147

Maximum amount of BOD collected in a day for eventual treatment estimated at 3,114 lbs

Flowthrough rate for treatment process is estimated to improve by 178%, allowing faster drawdown of storage during prolonged events

Permit Compliance

Compliance with permit limits for maximum daily concentration not evaluated

Compliance with permit limits for maximum daily loads not evaluated

Water Quality

Impact on oxygen concentrations in receiving waters not evaluated

Purchases of Product

No changes expected in volume of product purchased annually

Decrease of $20,375 in annual costs

Other

Figure 2. Pittsburgh ANG Evaluation (continued)

EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS

This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory compliance, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF currently in use. The evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions regarding a switch to the new formulation.

It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

SITE INFORMATION

Site Name	Bangor ANG
Address	101 ARW/EM 99 Glenn Ave Suite 494 Bangor IAP, ME 04401
Person filling out form	Lt Col D. Eric Johns, Environmental Manager
E-mail Address	eric.johns@mebngr.ang.af.mil
Telephone Number	207-990-7407

CURRENT SITUATION

NPDES Storm Water Permit Information

1	Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1	YES / NO	
2	NPDES permit number	2	MER05A911	
3	Permitting authority	3	Maine DEP	
	Permit limits during periods of peak deicing activity		BOD5	COD
4	Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4	100	
5	Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5		

Current Type I Deicer Information (See MSDS and manufacturer's literature)

			Type I
6	Decay rate at 20°C (1/day)	6	0.18
7	BOD5 concentration of propylene glycol (mg/L)	7	650,000
8	Percent glycol in purchased product	8	88.00%
9	BOD5 concentration in the purchased product (mg/L)	9	572,000
10	96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10	10,800
11	48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11	14,000
12	Aquatic toxicity (LC50) for other organisms (mg/L)	12	
13	Name of other test organism	13	Test
14	Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14	51,400
15	Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15	18,500
16	Typical application strength of purchased deicer (100% = no dilution of purchased product)	16	50%
17	Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17	25,700
18	Cost of aircraft deicer at purchased concentration ($/gallon)	18	$8.63

Deicer Collection and Storage

19	Do you collect deicing runoff for storage and treatment?	19	YES / NO
20	Collection technique	20	Designated deicer pads (50-70%)
21	Estimated collection efficiency (percent of applied glycol)	21	50%
22	Estimated losses of uncollected deicer fluid (percent of applied glycol)	22	30%

Treatment Information

			Flow	BOD5	COD
23	Maximum daily amount accepted for treatment	23	25000	2500	
24	Units	24	GPM	LB/D	N/A
25	Unit cost	25	0.0059	$0.23	

Tools and Models

26	Have other water quality tools or models been applied to your site?	26	YES / NO

KNOWN PROBLEMS

Exceedances of Permit Limits

27	Do you periodically exceed your concentration limits for BOD5 or COD?	27	YES / NO	
			BOD5	COD
28	If so, what is the highest observed daily concentration? (mg/L)	28	140	
29	Do you exceed daily load limits for BOD5 or COD?	29	YES / NO	
			BOD5	COD
30	If so, what is the highest observed daily load? (lbs/day)	30	700	

Other Known Problems

31	Are there known negative environmental consequences of deicing discharges?	31	YES / NO

Description of the negative environmental consequence (optional): reduced oxygen levels; invertebrate (due to low oxygen)

Treatment Issues

32	Are costs of treatment for collected deicer fluid excessive?	32	YES / NO
33	Is existing treatment and onsite storage capacity adequate for needs?	33	YES / NO

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Figure 3. Bangor ANG Evaluation

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Characteristics of Alternative Deicer

34	Name of alternative deicer	34	LBOD
35	Decay rate at 20°C (1/day)	35	0.04
36	Specific gravity	36	1.154
37	BOD5 concentration	37	270,000
38	BOD5 units for alternative deicer	38	MG/L
39	96-hour aquatic toxicity (LC50) for minnows (mg/L)	39	9,725
40	48-hour aquatic toxicity (LC50) for daphnia (mg/L)	40	4,275
41	Aquatic toxicity (LC50) for other organisms (mg/L)	41	
42	Name of other organism	42	Test
43	Cost of alternative deicer product at purchased concentration ($/gallon)	43	$7.00
44	Typical application strength of purchased alternative deicer (100% = no dilution of product)	44	50%
45	Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	45	1.00

Impact on Permit Exceedances

			BOD5	COD
46	Estimated new maximum daily concentration (mg/L)	46	N/A	N/A
47	Compliance with permit limit on concentration likely?	47	N/A	N/A
48	Estimated new maximum daily load (mg/L)	48	N/A	N/A
49	Compliance with permit limit on load likely?	49	N/A	N/A

Impact on Treatment

50	Estimated reduction in treatment charges	50	$78,508
51	Estimated maximum daily BOD load for treatment (lbs)	51	15,891
52	Treatment flowthrough improvement	52	178%

Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)

53	Do you discharge to a river or stream?	53	YES / NO	
			Upstream	Discharge
54	Dissolved oxygen concentration (mg/L)	54	9.0	5.0
55	Temperature (°C)	55	5.0	2.0
56	Stream flow (typical) during deicing discharges (cfs)	56	5.00	
57	Upstream BOD5 (mg/L)	57	1.0	
58	Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)	58	2.00	*(Estimate not available)*
	a *Stream depth (feet) (required)*	***a***		
	b *Stream width (feet) (width or velocity required, both may be entered if available)*	***b***		
	c *Stream velocity (fps) (width or velocity required, both may be entered if available)*	***c***		
	d *Slope (optional)*	***d***		
	e *Stream character (unknown, pool and riffle, or channel control)*	***e***	Unknown	
59	Estimated improvement in minimum dissolved oxygen (mg/L)	59	N/A	

Impact on Purchases of Product

			New	Change
60	Estimated annual new product purchases (gallons) and *change from current purchases*	60	25,700	*No change*
61	Estimated annual new product purchase costs ($) and *change from current cost*	61	$179,900	*-$41,891*

SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT

Aquatic Toxicity

Reported aquatic toxicity as measured by minnow LC50 improves (10,800 mg/L to 9,725 mg/L)

Reported aquatic toxicity as measured by daphnia LC50 improves (14,000 mg/L to 4,275 mg/L)

No comparison for Test LC50 possible

Treatment

Annual cost to treat collected deicing fluid is estimated to be reduced by $78,508

Maximum amount of BOD collected in a day for eventual treatment estimated at 15,891 lbs

Flowthrough rate for treatment process is estimated to improve by 178%, allowing faster drawdown of storage during prolonged events.

Permit Compliance

Compliance with permit limits for maximum daily concentration not evaluated

Compliance with permit limits for maximum daily loads not evaluated

Water Quality

Impact on oxygen concentrations in receiving waters not evaluated

Purchases of Product

No changes expected in volume of product purchased annually

Decrease of $41,891 in annual costs

Other

Other known environmental consequences of your deicing operations were indicated

Other water quality models or tools may be available that provide a basis for more detailed evaluation

Figure 3. Bangor ANG Evaluation (continued)

EVALUATION WORKSHEET FOR ALTERNATIVE AIRCRAFT DEICERS

This evaluation tool was designed to assist a Base Environmental Manager (EM) in assessing the likely environmental, regulatory compliance, and cost implications of a new Type I ADF formulation that is being considered as an alternative to the Type I ADF currently in use. The evaluation is at a screening level, intended to give the EM a sound indication of the general direction and magnitude of changes and benefits that can be expected with a switch to the alternative ADF. This information is intended to support decisions regarding a switch to the new formulation.

It is essential to understand that the tool is not intended to replace more sophisticated analyses that may be required to support demonstrations of regulatory compliance or engineering design of deicing runoff management systems.

SITE INFORMATION

Site Name	Portland International Airport
Address	
Person filling out form	
E-mail Address	
Telephone Number	

CURRENT SITUATION

NPDES Storm Water Permit Information

1	Does your site have an NPDES Storm Water permit for discharge of deicing runoff?	1	YES / NO
2	NPDES permit number	2	
3	Permitting authority	3	
	Permit limits during periods of peak deicing activity		BOD5 / COD
4	Most stringent permitted discharge concentration (mg/L). Leave blank if there are no limits.	4	100 /
5	Most stringent permitted maximum daily load (lbs/day). Leave blank if there are no limits.	5	1000 /

Current Type I Deicer Information (See MSDS and manufacturer's literature)

			Type I
6	Decay rate at 20°C (1/day)	6	0.18
7	BOD5 concentration of propylene glycol (mg/L)	7	650,000
8	Percent glycol in purchased product	8	88.00%
9	BOD5 concentration in the purchased product (mg/L)	9	572,000
10	96-hour aquatic toxicity (LC50) for fathead minnows (mg/L)	10	10,800
11	48-hour aquatic toxicity (LC50) for daphnia (mg/L)	11	14,000
12	Aquatic toxicity (LC50) for other organisms (mg/L)	12	
13	Name of other test organism	13	Test
14	Annual volume of applied aircraft deicer mixture (gallons at working concentration)	14	42,000
15	Maximum daily volume of applied aircraft deicer mixture (gallons at working concentration)	15	20,700
16	Typical application strength of purchased deicer (100% = no dilution of purchased product)	16	50%
17	Calculated annual volume of aircraft deicer at purchased concentration (gallons)	17	21,000
18	Cost of aircraft deicer at purchased concentration ($/gallon)	18	$8.63

Deicer Collection and Storage

19	Do you collect deicing runoff for storage and treatment?	19	YES / NO
20	Collection technique	20	Apron drainage diversion (20-50%)
21	Estimated collection efficiency (percent of applied glycol)	21	46%
22	Estimated losses of uncollected deicer fluid (percent of applied glycol)	22	30%

Treatment Information

			Flow	BOD5	COD
23	Maximum daily amount accepted for treatment	23	0.2	1200	
24	Units	24	CFS	LB/D	N/A
25	Unit cost	25	0.0059	$0.25	

Tools and Models

26	Have other water quality tools or models been applied to your site?	26	YES / NO

KNOWN PROBLEMS

Exceedances of Permit Limits

27	Do you periodically exceed your concentration limits for BOD5 or COD?	27	YES / NO
			BOD5 / COD
28	If so, what is the highest observed daily concentration? (mg/L)	28	140 /
29	Do you exceed daily load limits for BOD5 or COD?	29	YES / NO
			BOD5 / COD
30	If so, what is the highest observed daily load? (lbs/day)	30	600 /

Other Known Problems

31	Are there known negative environmental consequences of deicing discharges?	31	YES / NO

Description of the negative environmental consequence (optional)

Treatment Issues

32	Are costs of treatment for collected deicer fluid excessive?	32	YES / NO
33	Is existing treatment and onsite storage capacity adequate for needs?	33	YES / NO

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Figure 4. PDX Evaluation

POTENTIAL IMPACTS OF ALTERNATIVE DEICER

Characteristics of Alternative Deicer				
34 Name of alternative deicer	**34**	LBOD		
35 Decay rate at 20°C (1/day)	**35**	0.04		
36 Specific gravity	**36**	1.154		
37 BOD5 concentration	**37**	270,000		
38 BOD5 units for alternative deicer	**38**	MG/L		
39 96-hour aquatic toxicity (LC50) for minnows (mg/L)	**39**	9,725		
40 48-hour aquatic toxicity (LC50) for daphnia (mg/L)	**40**	4,275		
41 Aquatic toxicity (LC50) for other organisms (mg/L)	**41**			
42 Name of other organism	**42**	Test		
43 Cost of alternative deicer product at purchased concentration ($/gallon)	**43**	$7.00		
44 Typical application strength of purchased alternative deicer (100% = no dilution of product)	**44**	50%		
45 Gallons of alternative deicer to achieve effectiveness of 1 gallon of PG-based deicer	**45**	1.00		
Impact on Permit Exceedances		BOD5	COD	
46 Estimated new maximum daily concentration (mg/L)	**46**	50	N/A	
47 Compliance with permit limit on concentration likely?	**47**	Likely	N/A	
48 Estimated new maximum daily load (mg/L)	**48**	216	N/A	
49 Compliance with permit limit on load likely?	**49**	Likely	N/A	
Impact on Treatment				
50 Estimated reduction in treatment charges	**50**	$59,019		
51 Estimated maximum daily BOD load for treatment (lbs)	**51**	16,358		
52 Treatment flowthrough improvement	**52**	178%		
Impact on Oxygen Depletion (minimum dissolved oxygen in receiving waters)				
53 Do you discharge to a river or stream?	**53**	YES / NO		
		Upstream	Discharge	
54 Dissolved oxygen concentration (mg/L)	**54**	10.0	8.0	
55 Temperature (°C)	**55**	4.0	4.0	
56 Stream flow (typical) during deicing discharges (cfs)	**56**	5.00		
57 Upstream BOD5 (mg/L)	**57**	10.0		
58 Stream reaeration coefficient at 20°C (1/day) (estimate below or enter a value)	**58**	1.10	*(Estimated = 0.52)*	
a *Stream depth (feet) (required)*	***a***	*5.00*		
b *Stream width (feet) (width or velocity required, both may be entered if available)*	***b***	*30.00*		
c *Stream velocity (fps) (width or velocity required, both may be entered if available)*	***c***	*0.20*		
d *Slope (optional)*	***d***			
e *Stream character (unknown, pool and riffle, or channel control)*	***e***	Channel control		
59 Estimated improvement in minimum dissolved oxygen (mg/L)	**59**	N/A		
Impact on Purchases of Product		New	Change	
60 Estimated annual new product purchases (gallons) and *change from current purchases*	**60**	21,000	*No change*	
61 Estimated annual new product purchase costs ($) and *change from current cost*	**61**	$147,000	*-$34,230*	

SUMMARY OF POTENTIAL BENEFITS OF NEW PRODUCT

Aquatic Toxicity

Reported aquatic toxicity as measured by minnow LC50 improves (10,800 mg/L to 9,725 mg/L)

Reported aquatic toxicity as measured by daphnia LC50 improves (14,000 mg/L to 4,275 mg/L)

No comparison for Test LC50 possible

Treatment

Annual cost to treat collected deicing fluid is estimated to be reduced by $59,019

Maximum amount of BOD collected in a day for eventual treatment estimated at 16,358 lbs

Flowthrough rate for treatment process is estimated to improve by 178%, allowing faster drawdown of storage during prolonged events

Permit Compliance

The change in maximum daily concentration from 140 mg/L to an estimated 50 mg/L makes future compliance likely

The change in maximum daily load from BOD5 lb/day to an estimated 216 lb/day makes future compliance likely

Water Quality

Impact on oxygen concentrations in receiving waters not evaluated

Purchases of Product

No changes expected in volume of product purchased annually

Decrease of $34,230 in annual costs

Other

Other known environmental consequences of your deicing operations were indicated

Other water quality models or tools may be available that provide a basis for more detailed evaluation

Figure 4. PDX Evaluation (continued)